



# Operational Restoration Framework

Woodland Caribou Habitat Restoration in British Columbia

British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural  
Development

March 2021

## Disclaimer

The information and recommendations presented in this report were based on the diligent review of available background environmental information using accepted professional practices and standards. The framework is intended to be used as a guidance document and does not supersede existing regulations. The framework (v1.0) is recognized as a living document. It is anticipated that this document will be revised to reflect updates made to regional restoration initiatives, changes made to provincial/federal legislation and/or changes to British Columbia authorizations processes.

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## Executive Summary

Habitat restoration is an integral component in British Columbia's approach to woodland caribou recovery. The goal is to restore large tracts of the woodland caribou's habitat and to limit human and predator movement. This framework has been developed to provide a consistent approach in how to plan, implement and monitor caribou habitat restoration initiatives in the province. It is intended for the use of individual restoration projects operating at the site level once priority areas have been confirmed at the caribou herd range-level (e.g., through strategic and/or tactical restoration planning, herd planning or some other prioritization process).

Four broad components of a restoration project are introduced and explained within the framework. Within each of these four broad components are recommended processes that will further aid in efficient project planning and delivery.

**Step 1** outlines key considerations when planning a restoration project, including engagement, overlapping tenures, field reconnaissance, and selection of treatment type(s).

**Step 2** consists of guidance related to restoration plan development including permitting and authorizations associated with the proposed treatment type and treatment area. Supporting information in the form of a restoration plan of the site may be completed at this stage to support permit applications and to summarize site information and treatment plans.

**Step 3** consists of guidance related to treatment delivery and quality control.

**Step 4** outlines monitoring considerations to evaluate treatment success. This consists of guidance on surveys to assess vegetation growth (survival and establishment surveys post-treatment). This step may also include monitoring the impact of the project on wildlife through remote cameras and other surveys.

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## Definitions

<b>Consultation</b>	A formal process conducted by the BC Government to help parties understand and consider potential adverse impacts of project decisions and substantially address them through constructive negotiation, accommodation, and reconciliation. The duty to consult cannot be delegated to third parties.
<b>Crown land</b>	Land that is owned by the provincial government. This type of land is available to the public for many different purposes from industry to recreation and research.
<b>Ecological restoration</b>	Restoration that uses habitat management actions that help restore habitat closer to a pre-disturbed state.
<b>Engagement</b>	Discussions, meetings, and otherwise sharing information between a third-party project contractor and potentially impacted rights holders (Aboriginal or Indigenous communities) or stakeholders. Potential project impacts and project option considerations to improve and strengthen the project plans and implementation are discussed and documented based on feedback.
<b>Functional restoration</b>	Restoration that consists of habitat management actions that are intended to slow or deter predator movement and limit motorized access in caribou habitat helping to reduce caribou mortality in the short term and reduce the need for ongoing predator control.
<b>Indigenous Knowledge</b>	An aboriginal community's understanding about the natural world within a particular area or region based on long-term occupancy and cultural knowledge transmission and practice. (Also, Indigenous Traditional Knowledge, Aboriginal Traditional Knowledge or Traditional Knowledge)
<b>Natural regeneration</b>	Sites that have been treated but not seeded or planted and rely on natural recruitment of seeds into the site.

<b>Qualified Environmental Professional</b>	Work that is required due to natural resource regulations requiring an individual to hold a specific professional designation and must have an area of expertise that is recognized in that regulation as one that is acceptable for the purpose of providing all or part of an assessment.
<b>Restoration</b>	The process of repairing damage to ecosystems and habitats to achieve conditions that emulate natural, self-regulating systems that integrate ecologically with the local landscape. A holistic approach to renewing native ecosystem.
<b>Restoration plan</b>	A document used to describe and communicate the nature of a restoration project, summarize site conditions, and describe restoration activities.
<b>Site preparation</b>	A mechanical, chemical, or hand treatment that modifies the site to improve the growing conditions for natural or artificial regeneration.
<b>Stakeholder</b>	Individuals or groups that may be impacted by the project. They may hold a form of tenure within the project area.
<b>Stocked</b>	Sites in which growing spaces are effectively occupied by tree seedlings that are alive and have achieved a minimum height and there is adequate room for continued development; the target for stocking has been achieved.
<b>Stocking</b>	In the context of this framework, stocking refers to a combination of density, survival, and a minimum height target, along with the presence of trees across the entire site.
<b>Survival assessment</b>	An interim assessment of seedling survival on treated sites, two to five years after reforestation.
<b>Tactical plan</b>	A forward-looking plan that goes beyond immediate steps but not as long term as a strategic plan. It is a plan that identifies restoration areas of highest and lowest priority in a caribou range and identifies specific steps to achieve a goal or objective.
<b>Treatment type</b>	A category of sections within a site that has received the same treatments (e.g., mounded, screefed, planted etc.)



## List of abbreviations

<b>ATV</b>	All Terrain Vehicle
<b>BCeID</b>	“BC electronic ID” is an online service for accessing BC government applications
<b>BCGW</b>	BC Geographic Warehouse
<b>BEC</b>	Biogeoclimatic Ecosystem Classification
<b>BWBS</b>	Boreal White and Black Spruce
<b>CHRF</b>	Caribou Habitat Restoration Fund
<b>CPB</b>	Caribou Program Board
<b>CWD</b>	Coarse Woody Debris
<b>ECCS</b>	Ministry of Environment and Climate Change Strategy
<b>ESF</b>	Electronic Submission Framework
<b>FCBC</b>	Front Counter BC
<b>FLTC</b>	Forestry Licence to Cut
<b>FPPR</b>	Forest Planning and Practices Regulation
<b>FRPA</b>	Forest and Range Practices Act
<b>FSP</b>	Forest Stewardship Plan
<b>FSR</b>	Forest Service Road
<b>GAR</b>	Government Action Regulation
<b>HCA</b>	Heritage Conservation Act
<b>HCTF</b>	Habitat Conservation Trust Foundation
<b>IK</b>	Indigenous Knowledge
<b>IIP</b>	Integrated Investment Plan
<b>IIS</b>	Integrated Investment Specialist
<b>LiDAR</b>	Light Detection and Ranging imagery
<b>MFLNRORD</b>	Ministry of Forests, Lands, Natural Resource Operations and Rural Development
<b>OGC</b>	Oil and Gas Commission
<b>OGMA</b>	Old Growth Management Area
<b>OLTC</b>	Occupant Licence to Cut
<b>RESULTS</b>	Reporting Silviculture Updated and Land Status Tracking System
<b>RUA</b>	Road Use Agreement
<b>SUP</b>	Special Use Permit
<b>UAV</b>	Unmanned Aerial Vehicle
<b>UTM</b>	Universal Transverse Mercator
<b>UWR</b>	Ungulate Winter Range
<b>WHA</b>	Wildlife Habitat Area
<b>WSA</b>	Water Sustainability Act



## Overview of Framework

Habitat restoration is an integral component to BC's approach to the recovery of woodland caribou (*Rangifer tarandus caribou*) population in ranges where they currently exist or in ranges where BC has prioritized re-establishment. Restoration aids caribou recovery through a decrease in predation on caribou by limiting predator access and hunting efficiency, limiting motorized access by humans, and ensuring that important habitat is restored to provide the caribou's ecological needs. Habitat restoration is also identified as a recovery strategy within federal recovery plans.

The Provincial Operational Restoration Framework for Woodland Caribou Habitat Restoration ("The framework") has been developed to provide a common approach to planning, implementing, and monitoring caribou site level restoration initiatives in British Columbia. The framework is not a precise guide to all steps required for implementation of a restoration project. Rather, it is meant to introduce the steps and tools that have proven successful for the coordination of past pilot caribou restoration projects in BC and Alberta and to summarize the regulations applicable to specific restoration activities conducted in the province.

The framework is designed to provide guidance to restoration planners and implementors after strategic prioritization and engagement have been undertaken and a restoration project site confirmed. It is recommended that users of this framework contact the regional Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD) to confirm local requirements prior to starting a restoration project.



IMAGE 1: ITCHA-LIGACHUZ CARIBOU

## Adaptive Management

In keeping with the principles of adaptive management<sup>1</sup>, the framework is intended to be a living document and updated as needed to keep pace with legislation, policies, and operational requirements. Feedback based on lessons learned as the framework is utilized to advance restoration efforts will be used to improve the framework.

## Provincial Caribou Recovery Program

The Provincial Caribou Recovery Program was established in 2017 with a dedicated budget and mandate to aggressively pursue new recovery measures for caribou through a coordinated provincial program. It is guided by the following vision and mission:

**Vision:** Conservation and recovery of British Columbia's caribou through excellence in resource stewardship.

**Mission:** To lead caribou recovery through a comprehensive, collaborative, and accountable provincial program.

Leadership of the Program is provided by the Caribou Program Board (CPB) which provides strategic and policy direction on caribou recovery across BC and sets operational priorities and annual budgets. The CPB is comprised of Assistant Deputy Ministers from the Ministries of FLNRORD and the Ministry of Environment, and Climate Change Strategy (ECCS). The program is delivered by MFLNRORD and the ECCS and strives to achieve a single overarching goal related to the recovery of identified woodland caribou herds (Goal A) and three supplementary goals:

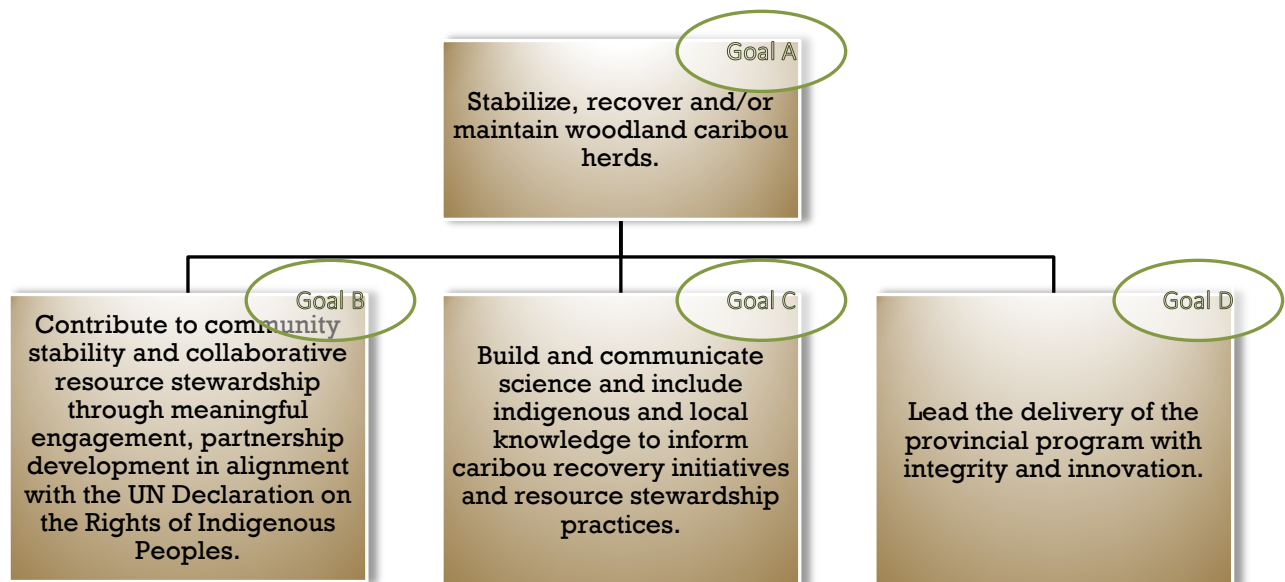


FIGURE 1. PROVINCIAL CARIBOU RECOVERY PROGRAM.

<sup>1</sup> Williams, 2011

Achieving Goal A relies on the implementation of a variety of caribou population and habitat management tools such as the following:

- Habitat protection
- Habitat management via best management practices
- Habitat restoration
- Maternal penning
- Primary prey management
- Predator management
- Supplemental feeding

The program relies on science and partnerships to inform decisions and implementation of recovery and management actions. Habitat restoration is one tool in the toolbox to support caribou recovery, but it will not recover caribou on its own. Ideally, areas prioritized for restoration at the site level are complemented by the implementation of other recovery and management tools such as habitat protection, predator management, etc.



IMAGE 2: SUPPLEMENTAL FEEDING

## Restoration Objectives

There are three dependent objectives of caribou habitat restoration:

1. Controlling access into caribou habitat by predators and humans.
2. Accelerating the rate of recovery of native vegetation.
3. Over the long term, providing habitat that supports the life processes of caribou populations and is used by caribou equally as much as undisturbed areas.<sup>2</sup>

The desired outcome of caribou habitat restoration is to not only create large intact high value habitat over the longer-term, but to also shift lower quality habitat that has been disturbed by humans into higher quality habitat with a specific focus on addressing linear disturbance effects on wolf movement and subsequent predation risk to caribou. High value habitat is most often identified as core habitat in BC and usually consists of high elevation winter/summer range and low elevation winter range. While site-specific restoration objectives may vary, restoration should focus on linear disturbances in core caribou habitat and/or in matrix habitat adjacent to core caribou habitat (e.g., where linear features span matrix habitat into core winter range).

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<sup>2</sup> Golder, 2016

## Caribou Habitat Restoration Types

Caribou habitat restoration can be categorized as functional or ecological. Functional restoration consists of habitat management actions that are intended to slow or deter predator movement and limit motorized access in caribou habitat helping to reduce caribou mortality in the short term and reduce the need for ongoing predator control. Ecological restoration uses habitat management actions that help restore habitat closer to a pre-disturbed state. This increases the amount of intact caribou habitat over the long term and returns ecosystems to a naturally functioning state. Ecological restoration is considered the most effective in the long-term for broad ecological goals but will likely take longer to achieve reductions in predation rates and costs are also higher.<sup>3</sup> Ideally, functional and ecological restoration are combined to achieve both short-term and long-term goals. Distinguishing between functional and ecological restoration objectives when designing restoration projects and selecting appropriate treatments are important but does not mean a restoration project can only achieve one objective or the other.<sup>4</sup>

**Ecological Restoration: Actions designed to restore habitat closer to a pre-disturbed state.**

**Functional Restoration: Actions that are intended to slow or deter access into caribou habitat by predators, primary prey, or motorized vehicles.**

A brief explanation of each method and some associated treatments is summarized in Table 1.

**TABLE 1. THE APPLICATION OF FUNCTIONAL AND ECOLOGICAL HABITAT RESTORATION.**<sup>5</sup>

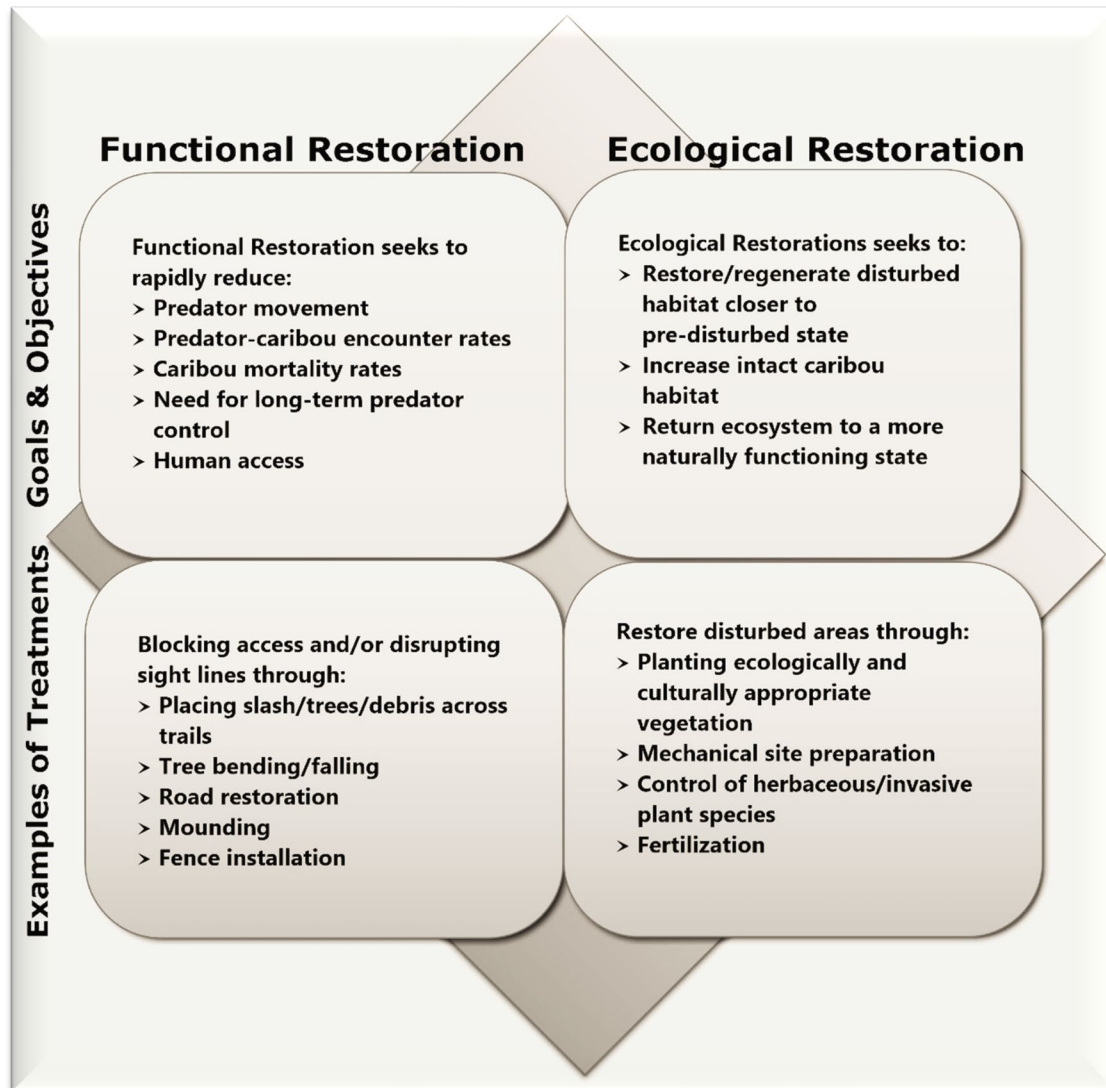
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<sup>3</sup> Golder, 2018

<sup>4</sup> SERNbc 2018

<sup>5</sup> Summary by DWB Consulting 2019





## Considerations

Indigenous Knowledge (IK) plays an important role in the stewardship and management of caribou in BC and is a valued component to any restoration planning effort. Incorporating Indigenous Knowledge and participation in all stages of a restoration project can help to advance restoration efforts in terms of history, priorities, values, and knowledge of habitat use patterns, predators, and considerations of native plants for recovery<sup>6</sup>. Utilizing both Indigenous Knowledge and western approaches create a more comprehensive and robust restoration strategy that is especially important during the early planning stages.<sup>7</sup> It is important to note that higher level tactical restoration plans that have been developed or that are under development in BC have strived to include Indigenous Knowledge considerations.<sup>8</sup>

<sup>6</sup> Polfus et al 2014

<sup>7</sup> DWB 2019

<sup>8</sup> DWB 2019

Considering climate change in planning restoration projects is challenging as there are many uncertainties surrounding its impacts and the implications on caribou habitat. Climate change may result in habitat changes that favour other prey species which may increase predator populations and facilitate the spread of disease and forest insects causing tree mortality. All MFLNRORD regions have a climate action plan that may provide guidance on integrating climate change considerations into a restoration project.

Regional Climate Action Plans can be accessed [here](#).

Restoration implementors that are unable to access this site should contact their local MFLNRORD office.

### Framework Organization

The framework is intended to help guide site-level restoration projects once priority areas have been confirmed at the caribou herd range-level. The framework is meant to provide a consistent approach in how to prepare, execute, and evaluate a restoration project. This will be done by referring to four broad components in a restoration project. Within each of these four broad components are recommended processes that will further aid in efficient project planning and delivery.

**TABLE 2. GENERAL COMPONENTS OF A RESTORATION PLAN.**

Planning	Permitting	Treatment Delivery	Monitoring
The first step outlines key considerations in <i>planning</i> a restoration project, including engagement, overlapping tenures, field reconnaissance, and selection of treatment type(s). This is covered in Chapter 2.	The second step (covered in Chapter 3) consists of guidance related to <i>permitting</i> and/or authorizations associated with the proposed treatment type and treatment area. Supporting information in the form of a restoration plan for the site may be completed at this stage to support permit applications and to summarize site information and treatment plans.	Step 3 consists of guidance related to <i>treatment delivery</i> and quality control. Further detail is contained in Chapter 4.	Step 4, detailed in Chapter 5, outlines <i>monitoring</i> considerations to evaluate treatment success. This consists of guidance on surveys to assess vegetation growth (survival and establishment surveys post-treatment). This step may also include monitoring the impact of the project on wildlife through remote cameras and other surveys.

## Restoration Planning Considerations



The initial step when drawing up any restoration program is planning. It is important to consider a host of different factors to ensure any habitat restoration plan is thorough, accurate, and effective.

Developing a restoration plan or site level plan that summarizes site conditions and treatments is recommended. Different regions may refer to this plan under different names such as management plan, site plan, or site prescription. The recommended contents are the same regardless of what name the plan is referred to in each region.

Summarizing site specific information and proposed restoration treatments plan will help contribute to information that can be implemented in future restoration projects.

### Planning Site Level Restoration

The planning stage considers the ecological, logistical, cultural, and regulatory site-level factors for a proposed restoration location. These considerations establish the most appropriate treatment method to achieve habitat restoration.

**Why should it be done?** A successful habitat restoration project requires careful consideration of multiple site-limiting factors such as overlapping tenures or land ownership, access, site conditions, future development plans, adjacent forest attributes, and potential level of reuse by predators and humans, to name a few. Many of the above noted considerations can be investigated via desktop mapping tools.

**How should it be done?** Restoration implementors are encouraged to engage with MFLNRORD for support with any part of the planning process whether this is required or not. Regional caribou habitat restoration contacts can provide information on the status of higher-level restoration plans and details on other restoration initiatives. Coordination of restoration projects is important to ensure priority areas are not inadvertently ignored. It is also recommended that restoration implementors seek relevant professional advice from a Qualified Environmental Professionals (QEP) familiar with caribou habitat, silviculture practices, and the project area to assist with habitat restoration project planning.

### Field Reconnaissance Survey

The aim of a field reconnaissance survey is to identify site specific considerations and to collect site specific information that will help support required permits and management plans (see Appendix B Restoration plan checklist).

**Why should it be done?** A field investigation should be performed to better assess the site and confirm if the site is a restoration candidate. More detailed site information can be collected at this time that will directly inform a site level prescription.

**How should it be done?** This field reconnaissance survey should take place under snow free conditions to allow for an assessment of the current soil and vegetation status. In addition, the field survey will

allow the proponent to review and confirm access routes and check for potential watercourse, pipeline, or road crossing locations.

### Engagement

Engagement is strongly encouraged with First Nations, stakeholders and stakeholder groups, local government, and active tenure holders with overlapping interests prior to completing restoration site planning reviews and field reconnaissance surveys.

**Early and effective engagement is critical to ensure there are no conflicts with the proposed restoration site(s).**

**Why should it be done?** Engaging early in the site planning process with First Nations and other resource partners ensures they are part of the process and can contribute their knowledge and information. It will also help determine if there are any conflicts where site restoration is being considered. Including First Nations in the field reconnaissance work may be valuable to the restoration project.

If specific permits are required as part of the restoration project, it is advantageous to prepare a stakeholder and First Nations engagement plan. Providing a summary of who has been engaged and documenting concerns and strategies will assist provincial application reviewers during the formal consultation phase and in making recommendations to decision makers.

**How should it be done?** Restoration implementors should provide First Nations and stakeholders adequate time to review and respond to an outline of proposed restoration activities. Based on feedback received during this engagement, candidate sites for initial treatment may need to be removed or refined due to overlapping use or concerns raised by First Nations or stakeholders. Once applications or authorizations are submitted to the Province, formal consultation with First Nations by the authorizing agency may be required and upfront engagement by the restoration implementor can positively influence the timing and nature of conditions associated with a decision.

### Treatment Area Selection

This framework focusses on the restoration area at the site level within those priority areas. Landscape and herd prioritization is a process completed by MFLNRORD.

**Why should it be done?** Tactical plans (higher level restoration plans) will set out priority areas specific to caribou subpopulation ranges.

**How should it be done?** Selecting a site for restoration within a priority area should consider a combination of ecological, regulatory, land use, cultural, and logistical criteria. Table 3 summarizes some example criteria that can be used to select sites for restoration within a caribou range. Treatment area selection will depend on site level conditions which may support individual functional and ecological treatment types or a combination of the

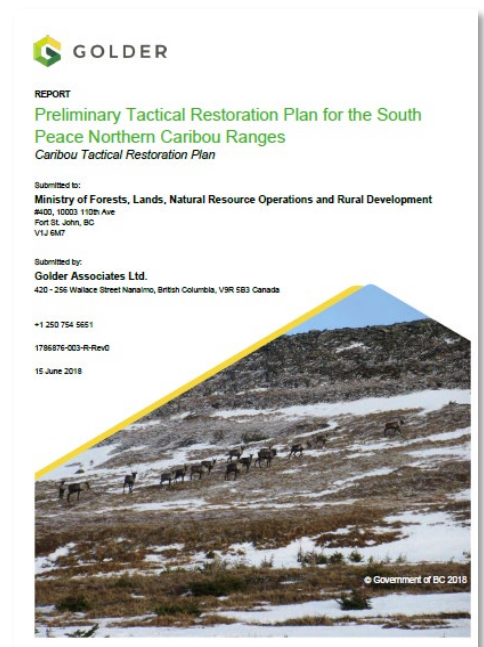


IMAGE 3: TACTICAL PLAN

two.

**TABLE 3. CRITERIA TO HELP SELECT AREAS FOR RESTORATION WITHIN A CARIBOU RANGE.** <sup>9</sup>

Ecological	Logistical
<ul style="list-style-type: none"> <li>✓ Caribou locations, high use areas</li> <li>✓ Predator locations/numbers and overlap with caribou (biologically meaningful area such as a wolf pack territory area)</li> <li>✓ Seismic line density disturbance levels</li> <li>✓ Mortality event locations</li> <li>✓ Existing natural vegetation recovery (leave for natural)</li> <li>✓ Disturbed sites that have a high probability of not regenerating naturally without intervention</li> </ul>	<ul style="list-style-type: none"> <li>✓ Costs (mounding/seedlings \$12,000/km)</li> <li>✓ Accessibility, ground conditions</li> <li>✓ Available seed source and seedlings (timeline)</li> <li>✓ Available sites (polygonal and linear disturbances not under active disposition, designated trails, and not falling under existing reclamation requirements)</li> <li>✓ Predicted natural recovery (fine scale attributes; vegetation height/cover, wetness, nutrients, distance to road, forest stand)</li> <li>✓ Stakeholder engagement</li> </ul>
Regulatory	Cultural
<ul style="list-style-type: none"> <li>✓ Outside Fire Areas &lt;40 years</li> <li>✓ Disturbance under active dispositions on Crown Land 'No Treatment', consider reclamation requirements</li> <li>✓ Outside future harvest management plan areas</li> <li>✓ Outside mountain pine beetle current distribution and susceptibility ranking</li> <li>✓ Limited future development potential</li> <li>✓ Limited stakeholder conflicts</li> <li>✓ Type of disturbance</li> </ul>	<ul style="list-style-type: none"> <li>✓ Oral history; high value caribou habitat</li> <li>✓ Indigenous Knowledge (knowledge holders, previous studies, studies) [important caribou environmental features, critical areas, observations, kills]</li> <li>✓ Winter foraging areas (fine resolution forage potential in winter based IK)</li> <li>✓ Critical Cultural Interest Areas</li> <li>✓ Avoidance of, or mitigating impacts from treatments to archaeological sites or high potential sites</li> </ul>

<sup>9</sup> Modified from Golder BCIP Restoration Framework 2018



## Criteria for Treatment and No Treatment Determination

It is important to develop specific benchmarks or criteria to help determine the viability of restoring certain habitat areas. Criteria helps set out which areas should be treated, untreated, or left for natural regeneration.

**Why is it important?** Criteria for treatment and no treatment classifications are considered during tactical planning. However, within a restoration project area, there may be portions of the site that do not require treatment.

**How should it be done?** Professional judgement should be relied upon to propose treatment and no treatment areas within a restoration project area. General definitions and criteria that can be utilized for this more operational level determination are outlined in Table 4 below, though specific criteria will vary based on site-specific conditions and project goals.

**TABLE 4. DEFINITIONS AND CRITERIA FOR TREATMENT FEATURE DETERMINATION.**

Treatment	No treatment*	Leave for natural regeneration
Disturbed areas not demonstrating natural regeneration and unlikely to regenerate naturally within a reasonable timeframe (i.e., all cover classes are under 0.5m height or 30% cover)	Areas that are naturally not treed	Vegetation cover is naturally developing and on a trajectory to regenerate to 3m height within 30 years
Disturbed areas not previously treated for restoration upon completion of development (e.g., historic seismic lines)	Existing active dispositions/tenures (e.g., pipelines, mines, cut blocks or lease roads)	Lack of human/predator access
Human/predator access (identified during tactical planning) that may negatively impact caribou	Protective notations such as riparian areas, protected grasslands, archaeological sites	Outside of or not adjacent to core caribou habitat
	Safety hazards such as steep terrain	
	Continued human use of the area (i.e., recreational)	
* Professional judgement should be applied here as there may be specific mitigation actions that can be implemented to reduce the impact of the above noted criteria		

Active tenures or dispositions within or adjacent to a proposed restoration treatment area can be found as part of a desktop mapping exercise. A list of relevant layers found in the BC Data Catalogue are summarized in Appendix E. Several other mapping sources are available online that can aid with the



collection of information that may be required for purposes of engagement and site level planning. These include the following:

- Base mapping, satellite and Light Detection and Ranging (LiDAR) imagery
- Current BC Local Population Unit and/or range boundaries
- Current BC caribou habitat type boundaries (e.g., high elevation winter range, high elevation summer range, low elevation winter range, matrix)
- Habitat Suitability or Capability Models, if applicable, or where habitat type boundaries are not available
- Disturbance mapping/analysis

The spatial layers described above are largely publicly available through either GeoBC<sup>10</sup> or iMapBC.<sup>11</sup> Overlap summary reports can be generated using the Natural Resources Online Services.<sup>12</sup> The restoration implementor is encouraged to contact the MFLNRORD to access any additional databases which may not be publicly available such as telemetry data and First Nation traditional territory information.

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<sup>10</sup> <https://www2.gov.bc.ca/gov/content/data/about-data-management/geobc>

<sup>11</sup> <https://www2.gov.bc.ca/gov/content/data/geographic-data-services/web-based-mapping/imapbc>

<sup>12</sup> <https://portal.nrs.gov.bc.ca/web/client/explore>

## Developing a Restoration Plan



Permits or authorizations that are necessary as part of a restoration treatment on Crown land often require supporting information if that restoration activity is not being conducted by a forest tenure holder. The information in this plan assists Ministry staff reviewing permit applications and in making recommendations. Many permit authorizations require the Province to complete First Nation consultation according to established agreements. Information in the plan will aid in providing information to First Nations and other stakeholders during this government review process. Depending on the type of permit and authorizing agency, the inclusion of specific supporting information may be required. The local district office can confirm district and permit specific requirements.

To provide time for consultation, review, and feedback, permits and supporting plans should be submitted to the relevant MFLNRORD office via [Front Counter BC](#) in advance of the proposed treatment(s) (See section 3.1.3 for more detailed information).

Upon plan submission, the Ministry will carry out a ‘status’ report to ensure that the submitted plan does not conflict over an existing right, interest, or obligation on the land or resource. Where there are other interests, MFLNRORD will send other tenure holder referrals on the proposed activity. For this reason, it is important that early engagement is conducted to address potential conflicts.

**Proponents are advised to reach out to MFLNRORD as early as possible in the planning process.**

**Allow at least 6 months for processing permits and authorizations.**

## Recommended Plan Components

The plan should provide two key components:

1. Information to support a fair and equitable assessment of the use of Crown land and the management/conservation of forest resources
2. Information to support required permits and authorizations

The complexity of the restoration project will dictate the level of detail (an example of a plan format is available in Appendix D).

It is recommended that any plan should have the following information:

- Project identification information and objectives
- Site location map(s), shapefile with polylines and/or polygons
- Authorization and permit requirements
- Engagement with First Nations, trappers, guide outfitters, and area clubs
- Management practices (where applicable)
- Treatment area summary
- Access to pre- and post-treatment site(s)

- Monitoring treatment plan (recommended and may be required as part of funding or a condition of the permit)

To support the successful development of a plan, a checklist should be developed to address key items (examples of key items are provided in Appendix C). The sections below provide more detailed information on key components described in the plan.

### Project Identification and Objectives

The plan should summarize general tenure information applicable to the project area such as Timber Supply Area (TSA), forest district, Universal Transverse Mercator (UTM), and geographic location. The caribou herd within the plan area will be noted. A short statement on project objectives will provide a summary of the general rehabilitation plan (e.g., de-compaction by mechanical site preparation, tree planting, mounding, and tree bending) and the desired goal of the restoration plan (e.g., reduce predator access and provide lichen forage).

### Maps

It is helpful that maps included in the plan contain the appropriate information in order facilitate research and assessment. The following are considerations that should be considered when developing a map:

- The plan should include a general site location map at a larger scale showing distances from the nearest town or other landmarks highlighting proposed access routes. Access routes should be strategically planned to limit ground disturbances and reduce travel times.
- Detailed maps at a smaller scale such as 1:10,000 should show restoration sites split into treatment units, streams, roads, and other relevant layers applicable to land use within the site.
- Documents in shapefile (.shp) or Google Earth (.kml) file formats as well as polylines or polygons of areas being restored should also be submitted.

### Authorizations and Permit Requirements

Any restoration activity undertaken on Crown land in BC that requires the cutting of trees (including shrubs and non-merchantable trees), ground disturbances, or work in or around water requires an appropriate authorization by the Province of BC. Authorizations are required whether the activity is being conducted by industry, First Nations, a public group, or provincial agency. If a specific level of protection on the restoration project is desired, this is also done through an authorizations process.

The plan should summarize the regulatory permits and approvals that have been or will be obtained in preparation for the proposed restoration. If the permit requires any specific conditions, such as monitoring, this should be included in the plan.

Any permits and approvals required to carry out the restoration work must be in place prior to implementing the work. Depending on the project, the permitting application process may take different lengths of time due to the Province's internal review requirements and responsibility to consult with First Nations. A QEP can assist with the permitting application process. It is

encouraged that the local MFLNRORD or Front Counter BC (FCBC) office be contacted early to discuss the permitting process and requirements in the development stages of restoration planning. Notifications and approvals are the responsibility of MFLNRORD and may be obtained through FCBC.<sup>13</sup> Information on different activities and authorizations can be explored on the Natural Resource Online Services portal at the following website:

<https://portal.nrs.gov.bc.ca/web/client/home>.

Where a commitment to restore habitat under authorization exists, these commitments become legally binding as an enforceable condition under permit.

The following table provides guidance on the authorizations and permits that are more generally applicable to terrestrially based restoration work. This list is not exhaustive and the proponent is encouraged to seek advice from the MFLNRORD and/or a QEP to guide this process.

**TABLE 5. RELEVANT AUTHORIZATIONS BY TREATMENT TYPE.<sup>14</sup>**

FOREST ACT		
ACTIVITY/PRACTICE	SECTION	APPLICATION
Ground disturbance (mounding, mulching, planting) on crown land.	s. 52	Approval to occupy Crown land when activities are conducted by a provincial agency (government staff or through a government contract).
Tree cutting or bending by non-provincial agency.	s. 47.6	A Forestry License to Cut (FLTC) is required where the proponent is cutting crown timber where the volume does not exceed 500m <sup>3</sup> . Purposes include small scale salvage, fuel reduction, scientific investigation, and First Nations direct award.
Tree cutting.	s. 47.4 (2)(a)	An Occupant License to Cut (OLTC) is required for the cutting or cutting and removal of Crown timber from Crown land or private land. The applicant must hold a right to occupy and use the land being harvested through a “right of occupation”, a lease, or special use permit (see SUP below). If the OLTC only authorizes the cutting of Crown timber, a FLTC could be issued to another person to remove the merchantable timber cut under the OLTC. *See FPPR in FRPA for practice requirements that may apply to an OLTC.
Road Permit Roads.	s. 115	Forest Act road permits are issued to forest licensees with a right to harvest timber. Road permit roads are managed by forest licensees. Other permit roads may be administered by the oil and gas or mining industry. Restoration proponents are required to enter into Road Maintenance Agreements (RUA) with the Primary Road User.
Access via a Forest Service Road (FSR).	s. 117	FSRs are maintained by the forest industry under road use permits or where there is no industrial maintainer, the MFLNRORD carries out maintenance. Proponents are required to obtain a Road Use Permit from the MFLNRORD if there is no primary industrial user with an RUA.

<sup>13</sup> <http://www.frontcounterbc.gov.bc.ca/>

<sup>14</sup> Format from DWB Consulting 2020

## Operational Restoration Framework: Developing a Restoration Plan

FOREST PRACTICES CODE		
ACTIVITY/PRACTICE	SECTION	APPLICATION
Authority to occupy an area of Crown Land.	Provincial Forest Use Regulation Part 3 s. 8-13	Special Use Permit (SUP) Forestry is required if occupancy of Crown land within a provincial forest is required. If restoration is outside of the provincial forest, see Land Act. Section 9 of the PFUR requires the applicant submit a plan that sets out how the land will be used (see Appendix D for a plan template).
Access on a non-status road on Crown land by a non-forest industry.		Special Use Permit is required if modification or use of a non-status road is needed for a restoration project.
FOREST AND RANGE PRACTICES ACT		
ACTIVITY/PRACTICE	SECTION	APPLICATION
Restoration in a non-merchantable stand.	s. 52 s. 52.1	Where there is no revenue associated and the area to be restored is non-merchantable. The area District Manager will authorize the activity via s. 52 FRPA. See FLTC Forest Act if revenue aspect associated.
For an activity conducted by a forest or range licensee.	Forest Planning and Practices Regulation (FPPR) Part 4 s. 40, 43, 51, 53	s.40 where a road is deactivated, the soil exposed must revegetate within 2 years if erosion would cause sediment to enter a stream, wetland or lake. s. 43 Use of tree seed for planting. s. 51 restrictions to cutting trees in a riparian reserve zone. s. 53 where trees are cut within a riparian management area adjacent to a temperature sensitive stream or tributary to one, trees must be retained to prevent temperature increases.
For an activity conducted by a forest or range licensee.	FPPR Part 5	Applicable to associated roads work conducted by a forest licensee.
For an activity proposed within a UWR or WHA.	GAR	An exemption may be required if restoration work is proposed within an established WHA or UWR.
LAND ACT		
ACTIVITY/PRACTICE	SECTION	APPLICATION
Non provincial agency occupying Crown land to complete ground disturbance activity such as mounding, mulching, planting.	s. 39	A License of Occupation is available in remote areas or where the lands are needed for uses that are not permanent or where there are specific restrictions or management objectives. A license is typically issued for a term of 10 years. A temporary License of Occupation can be issued for up to two years to authorize a temporary use. A temporary license may be used to allow an applicant to investigate a potential location.
Establishes a conditional withdrawal over an area to support a planned project.	s. 17	Conditional withdrawal to support a provincial or federal government objective. Contains terms that specify the use(s) that may be authorized. Crown land will not be available for disposition inside this area for activities not deemed compatible with the terms of the withdrawal. A portion of Crown land may be designated for a particular use of for the conservation of natural or heritage resources.
Reserve placed over a restoration area.	s. 15	A reserve provides the strongest indication of governments intention and is used to safeguard public interest or concern. It may be established for a specific term.
Old Growth Management Area	s. 93.4	OGMA's are established by the minister responsible for the Land Act (for forestry and oil and gas activities). Tree falling restoration activities

## Operational Restoration Framework: Developing a Restoration Plan

		within an OGMA require a License to Cut. This permit would be referred to local district forestry or oil and gas staff for review and comment.
<b>WATER SUSTAINABILITY ACT</b>		
<b>ACTIVITY/PRACTICE</b>	<b>SECTION</b>	<b>APPLICATION</b>
Stream crossing in frozen conditions.	WSR Part 3 s. 36	Notification only as the specified change in and about a stream has minimal impact on the environment and third parties. Work must fit within one of the criteria noted in s. 36. Must be submitted a minimum of 45 days prior to initiating work. If you hear from a habitat officer prior to 45 days you may commence the work.
Diversion of water from a stream for caribou penning watering.	WSA s. 10 WSR s. 3	Section 10 lays out the use approval requirements and section 3 of the regulation notes all the information required in the submission. Approval process requires First Nation consultation.
Stream crossing in non-frozen conditions requiring complex changes in and about a stream.	WSA s. 11	Change approvals are granted with terms and conditions attached which may relate to the time of year in which you may work. The approval process requires First Nation consultation
Works exempt from approval or notification.		Approvals or notifications are not required if the work is carried out by a person who holds an agreement or road use permit under the <i>Forest Act</i> , <i>Range Act</i> or special use permit under the <i>Forest Practices Code of BC Act</i> or is authorized to modify a road under the <i>Coal Act</i> , <i>Geothermal Resources Act</i> , <i>Mines Act</i> , <i>Mining Right of Way Act</i> or <i>Petroleum and Natural Gas Act</i> .
<b>HERITAGE CONSERVATION ACT</b>		
<b>ACTIVITY/PRACTICE</b>	<b>SECTION</b>	<b>APPLICATION</b>
Ground disturbance activities such as mounding or tree planting, ditching etc.	s. 14	Completion of an Archaeological Overview Assessment is required if ground disturbance is occurring. A Heritage Inspection Permit as per s. 14 of the HCA may be required and is received from the BC Archaeological Branch (MFLNRORD).
<b>WILDLIFE ACT</b>		
<b>ACTIVITY/PRACTICE</b>	<b>SECTION</b>	<b>APPLICATION</b>
Removing beaver dams for restoration access.	s. 9	If a road is permitted, a permit to remove a beaver dam is not required.
Cutting trees.	s. 34	Cutting down a tree containing a nest which is occupied by a bird or its egg or is the nest of an eagle, peregrine falcon, gyrfalcon, osprey, heron is not permitted
Fish and wildlife general permit.		Restoration efforts may require wildlife, amphibian or fish salvage. Front Counter BC will guide a proponent through the process. Use of drone, UAV and/or helicopter for some surveys may also require a permit.
<b>MIGRATORY BIRD REGULATION</b>		
<b>ACTIVITY/PRACTICE</b>	<b>SECTION</b>	<b>APPLICATION</b>
Cutting or bending trees during nesting	s. 6	Subject to subsection 5(9), no person shall disturb, destroy, or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory



(typically between April and August).		bird.
<b>OIL &amp; GAS ACTIVITIES ACT</b>		
ACTIVITY/PRACTICE	SECTION	APPLICATION
Pipeline Crossings Regulations.	s. 2	Written permission is a requirement if activities are taking place within 30m of a pipeline. Planting trees within a pipeline right-of-way is prohibited. Road crossings or movement of vehicles and equipment across, on or along the right-of-way require an agreement with the pipeline holder. BC One Call must be contacted to obtain a right-of-way permit.
<b>BC WILDFIRE REGULATION</b>		
ACTIVITY/PRACTICE	SECTION	APPLICATION
Spreading of woody debris.	s. 25 or s. 26	Where spreading of woody debris is a method used to reduce access on a linear feature, the volume of woody debris and storage leading up to treatment may require an exemption from the local fire centre.

<b>CHIEF FORESTER'S STANDARDS FOR SEED USE</b>		
ACTIVITY/PRACTICE	SECTION	APPLICATION
Tree planting under the authority of the Forest and Range Practices Act.	s. 8.2 – 8.4	For a forest license area, seedlings or cuttings must be used in compliance with the geographically based seed transfer standards. For planting under other authorities, seed transfer standards are strongly encouraged to ensure better seedling survival.

## Engagement Summary

It is recommended that the plan include a summary of completed engagements and outcomes with First Nation groups, stakeholders, and other interest groups (refer to section 2.3). This will support any required consultation related to permits. Additional engagement is encouraged once the plan has been finalized so that interested parties can stay informed about proposed restoration activities.

## Management Practices

Applicable best management practices that should be applied to prevent negative impacts on environmentally sensitive features are summarized in this section. These may include practices to prevent the introduction and spread of invasive plants, reduced risk timing windows for fish and associated wildlife, bird nesting windows, soil compaction hazard, visual impacts, sensitive areas, and riparian areas to name a few.<sup>15</sup>

Summarizing existing site conditions as assessed during the field reconnaissance survey will demonstrate how the most feasible treatment options according to site conditions such as soil type, forest health, other species at risk, and biodiversity were chosen. The plan should also

<sup>15</sup>

[https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/wqg\\_summary\\_aquaticlife\\_wildlife\\_agri.pdf](https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf)

include general information about the environmental setting based on online data searches completed to assess if any sensitive features may be impacted during restoration activities.

### Treatment Area Summary

A detailed description of areas classified to be treated, not treated, or left for natural regeneration should be included in the plan referencing criteria used for selecting priority areas (see Section 2.5).

Currently, a wide range of functional and ecological treatment options are available and are being applied in habitat restoration projects across BC. Scheduling and timing of implementing treatment prescriptions are crucial. The best time to restore defined habitats will depend largely on the type of treatment prescribed and soil conditions. For example, mechanical site preparation methods are typically applied during frozen conditions to limit ground disturbance and compaction. Seed and seedling availability will also affect the timing of treatment delivery. It is encouraged to source these early in the planning phase of the restoration project to ensure all required materials will be available at the time treatment is scheduled. It is recommended to follow tree seed transfer guidelines as regulated through the Forest and Range Practices Act and Forest Planning and Practices Regulations to ensure seedlings have the best growing opportunities on the planting site.

The plan should outline the types of habitat restoration techniques proposed by treatment zones within the project area (e.g., tree bending/falling including density/km or ha, planting stems/hectare by species, etc.). This section of the report should outline how these techniques were chosen based on site conditions. Site limiting factors must be addressed as much as possible. A simplified treatment table is included below as an example.

**TABLE 6. EXAMPLE SUMMARY OF TREATMENT SUMMARY PRESCRIPTION.**

Treatment Unit	Area/Length	UTMs	Zone/Subzone/Variant/Phase	Site Series	Elevation	Soil Texture	Rooting Depth
Site Characteristics							
Age							
% Cover							
% CWD							
Height							
Lichen Cover							
Species							
SPH							
Successional STAGE							
Proposed Treatment							

A summary of some of the most common restoration treatments can be found in Appendix B. A supporting handbook, *Restoration Treatment Options*, is being developed and includes more specific information about different restoration treatments such as spacing and methods. Comprehensive treatment matrix tables have also been developed for linear feature restoration within the Boreal White and Black Spruce (BWBS) Biogeoclimatic Ecosystem Classification (BEC) zone.<sup>16</sup> These are included in the [Northeast Regional Habitat Restoration Toolkit](#)<sup>17</sup> and may be applicable to many other caribou ranges, not just the boreal caribou ranges.

Finally, photos of the treatment areas are also helpful to demonstrate existing site conditions.

### Access

The timing of restoration activities relies on available access and any access limitations, such as winter access systems, bridge load limits, and other road users. It is important to note any proposed connections to a forest service road that may require a Ministry of Transportation and Infrastructure permit, the type of forest service road, and types of vehicles expected. Information on any road use agreements should be included (see Table 4) and should describe any barriers or upgrades to existing access to areas required. The volume and type of traffic during the restoration project and season should also be included.

It is important to consider access for site monitoring post treatment. If road rehabilitation is a restoration treatment, alternate post treatment access options require planning.

### Monitoring Plan

Monitoring is critical to evaluate the effectiveness of a restoration treatment. Monitoring information can inform projects for adaptive management and future restoration planning. It is important to consider how project objectives will be measured and it is recommended that a monitoring plan be in place prior to starting restoration work if possible. The purpose of a monitoring plan is to help determine whether the restoration treatment was successful in achieving the plan's identified objectives. Reporting results of a restoration project are often a requirement of a funding body but are encouraged for use in all restoration projects. Section 5 explains monitoring in more detail.

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<sup>16</sup> Golder, 2015a

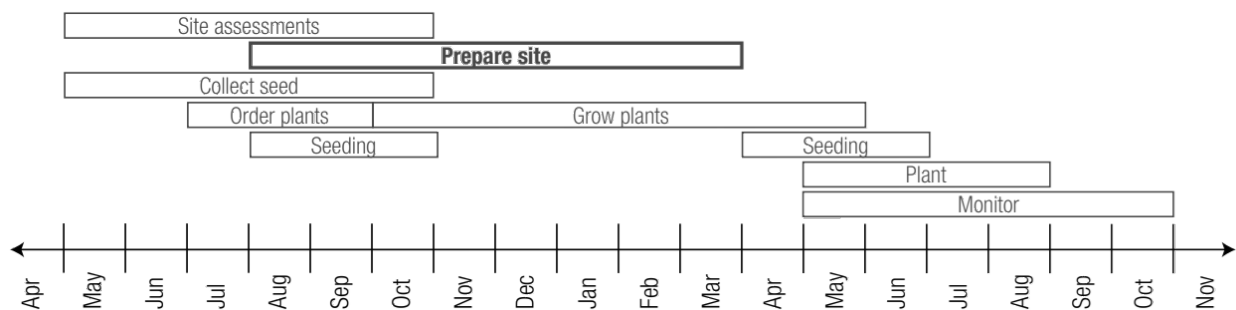
<sup>17</sup> Available in Golder 2015a

## Treatment Delivery



## Restoration Implementation

Once the plan and associated permits are approved, implementation of the plan can begin. As the figure below suggests, a typical restoration program can take almost a year to complete.



**FIGURE 2. DECIDING WHICH TECHNIQUE IS APPROPRIATE FOR SITE** NATURAL RESOURCES CANADA 2017 - TAKEN FROM A GUIDE TO SITE PREPARATION.

Practical and logistical considerations of implementation such as workforce availability and project timing need to be considered. Worksafe BC safety requirements such as signage may be required for specific treatment practices. Roads that have been deactivated or rehabilitated as part of a caribou restoration project must post signs to inform the public of the objective of growing trees in an undisturbed environment and warn potential users of the deactivation. Restoration projects must be barricaded in a clearly visible manner to prevent motor vehicle access or at least create a very difficult section for the first 100m to deter off-road users.<sup>18</sup>

## Quality Assurance and Compliance

Quality control should be implemented for a restoration project to ensure objectives are met. Quality control enables transparency amongst proponents and regulators and allows for improvements and consistency of restoration work.

Timing quality control surveys during field implementation is crucial to allow for immediate implementation of remedial actions or adjustments to the treatment should it be required. This will ensure equipment remains available on-site and will limit the time and cost required to complete any necessary alterations. Quality control surveys will also help determine if the contractor's activities are following the restoration contract and applicable permit conditions and thus assist with resolving payments for contractors.

<sup>18</sup> MFLNRORD Appendix 1 Criteria for Rehabilitating Roads

On most projects, quality control inspections or audits can be performed by a QEP. Quality control indicators are based on the specific treatments applied and generally assess the density, quality, and spacing of each treatment.

Quality control evaluations may be required as part of a permit condition. The proponent is also required to document any alterations or modifications to treatment that were made following the quality control survey.

For conducting a quality control audit, a proven quality control system should be applied. The BC Ministry of Forests Planting Quality Inspection Guide to Completing the FS 704<sup>19</sup> is one source which may be used to develop an audit system.

Quality control plots may be re-visited later during project monitoring. Permanently marking these established plots will aid in future monitoring activities (if required and if funded).

It is important to consider future access into a treatment area when choosing monitoring plot locations as plots may need to be re-visited during effectiveness monitoring later in the project.

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<sup>19</sup><https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/silviculture/tree-planting/plantingqualityinspecting.pdf>

## Monitoring



### Purpose and Objectives

Monitoring is the process of identifying and measuring key indicators of ecosystem response to a restoration treatment.<sup>20</sup> Monitoring is an important component of the restoration process and is essential to determine whether a project has been successful in achieving the restoration goals identified in the plan. A monitoring plan should be an integral component to a project's overall design because monitoring may also be a requirement of different restoration funded projects (e.g., Caribou Habitat Restoration Fund).

Restoration sites are unique and each monitoring plan will reflect this. Different monitoring components should be considered and can be carried out at different levels of intensity depending on the complexity, scale, and treatment option utilized in the restoration project.<sup>21</sup>

### Monitoring Surveys

Where monitoring is a required component of the restoration project, the monitoring phase of a re-vegetation restoration activity typically consists of a survival survey and an establishment survey (10-15 years post-treatment) to assess vegetation growth and treatment success. Advanced regeneration sites only require an establishment survey. For functional restoration treatments, monitoring the impact of the project on wildlife through remote cameras and other surveys may be a more appropriate method of monitoring.

### Survival Surveys

Survival surveys are recommended 1-5 growing years after a planting activity and 3-5 growing years after seeding or natural regeneration. A survival survey is the initial assessment of seedling survival and early response to vegetation. There are various sampling strategies that can be utilized. The goal is to ensure the sampling design assesses a representative percentage of the treatment area. Survey resources are available here: [Silviculture Surveys - Province of British Columbia](#). Results of a survival survey should be evaluated based on the recommended restoration targets. Where targets have not been met, remedial actions should be considered where possible. Remedial actions may include the replacement of seedlings that have died, manual vegetation control, or modified access control.

### Establishment Surveys

Establishment surveys are intended to be completed 8-15 years after treatment delivery. This survey is completed as a final check to assess whether the restoration site is on the trajectory of recovering desired vegetation and/or if predator and human access concerns have been

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<sup>20</sup> Machmer and Steeger 2002

<sup>21</sup> FRBC Ecological Restoration Guidelines for BC



addressed. This survey is applied at the program level and not typically the responsibility of the restoration implementor unless otherwise specified.

## Monitoring Plan Information

Collecting standardized information on the implementation of a restoration treatment can be used to inform future restoration efforts. Treatment information should include the suggested categories listed in Table 7 below; however, additional information may be necessary depending on the project and its objectives.

**TABLE 7. EXAMPLES OF REQUIRED BASIC INFORMATION DESCRIBING DEPLOYED RESTORATION TREATMENTS.** <sup>22</sup>

Restoration Method	Treatment Type	Timing of Treatment	Site Preparation	Tree/Shrub Species	Treatment Intensity	Length of Treatment (e.g., road or seismic)	Width (of treated area)	Average Height
Functional	Tree bending	February	None	Black spruce	30 stems/100m	200m	3-5m	1.25m
Ecological	Planting	June	Mounding	Spruce	1200 sph	1km	5-7m	18cm

A monitoring plan will link monitoring metrics to one or more of the plan's restoration goals. The following considerations will inform a project's study design, data to be collected, and how data will be analyzed (at the site scale):

- The project's goals and objectives
- Identifying what to monitor
- When a response is expected
- Monitoring time
- Logistical feasibility of the monitoring program
- Long-term costs

Appendix G and H provide examples of monitoring techniques available to evaluate the effectiveness of a restoration goal.

## Restoration Targets

As outlined in section 5.2, the survival survey will focus on the survival of seedlings and early response of vegetation growth, while the establishment survey will focus on assessing the density, height and survival rate of trees, as well as presence of human/predator trails.

To set a standard for quantifying restoration success, the framework utilizes general principles adopted by the forestry industry in BC. As such, the approach includes a consideration of consistency among the number and species of trees required to support a "free growing stand" – a stand of healthy trees not impeded by competition from other plants. Stocking standards are best applied to determine if and how stand objectives are met over time.

<sup>22</sup> CHRF Project Monitoring Guidance 2020

Since a high degree of variability in vegetation responses is expected for different sites within the regions of BC, specific targets for each will vary greatly and are not provided here but should be established during the planning phase (Section 2.0). This inconsistency mainly derives from varying natural site conditions such as BEC zones and site series, nutrients, and depth of water table. As site differences between moisture and nutrient regimes are expected, distinct restoration targets may need to be established for upland, lowland, and transitional restoration site units. In addition, there are significant differences amongst seedling species, planting preparation, and techniques and on-going levels of natural (e.g., wildfire) and human caused disturbances within different areas of BC. Therefore, acceptable tree species for restoration will vary based on the above-mentioned site variations.

It is encouraged that the MFLNRORD be consulted to help determine what restoration targets are appropriate. Stocking standards which account for density, height, and survival as well as standards for acceptable trees have been established and are well documented within forest stewardship plans developed for the various regions of BC. These may be utilized and adapted as approved by the MFLNRORD. Tables 8 and 9 below outline some of the evaluation criteria, indicators of success, and standards for targets generally recommended to be utilized to establish restoration goals for survival and establishment surveys.

**TABLE 8. GENERALIZED RESTORATION TARGETS FOR A SURVIVAL SURVEY\*.**

RESTORATION GOAL	EVALUATION CRITERIA/INDICATORS	TARGETS
<b>Vegetation Establishment</b>	<ul style="list-style-type: none"> <li>• Density (%) of live seedlings (stems/ha), including planted and natural regeneration</li> <li>• Percent cover of live seedlings</li> <li>• Vigour of live seedlings (i.e., presence of chlorosis or other health issues)</li> <li>• Vegetation community composition (conifers, shrubs, grasses etc.)</li> </ul>	<ul style="list-style-type: none"> <li>• Target survival rate, densities, and percent cover are specified in regional FSPs</li> <li>• No evidence of tree health issues</li> </ul>
<b>Access Control</b>	<ul style="list-style-type: none"> <li>• Evidence of access (Y/N)</li> <li>• Type of access (predators/other ungulates or Motorized vehicles, including all terrain vehicles (ATV), truck, snowmobile</li> <li>• Level of use (may be low with infrequent and few signs or high with tracks and ground disturbance very visible)</li> </ul>	<ul style="list-style-type: none"> <li>• Eliminated or reduced predator or motorized vehicle use following installation of access control</li> </ul>

\*Adapted from Golder, 2015b

**TABLE 9. GENERALIZED RESTORATION TARGETS FOR AN ESTABLISHMENT SURVEY\*.**

RESTORATION GOAL	EVALUATION CRITERIA/INDICATORS	TARGETS
<b>Vegetation Establishment</b>	<ul style="list-style-type: none"> <li>• Density (%) of targeted vegetation (stems/ha)</li> </ul>	<ul style="list-style-type: none"> <li>• Target stocking targets are specified in regional FSPs.</li> </ul>

	<ul style="list-style-type: none"><li>• Percent cover of targeted vegetation</li><li>• Height and leader growth of targeted vegetation</li></ul>	<p>This includes tree height and leader growth height</p> <ul style="list-style-type: none"><li>• Density, percent cover, and height should mimic adjacent undisturbed habitat</li></ul>
<b>Access Control</b>	<ul style="list-style-type: none"><li>• Evidence of access</li><li>• Line of Sight</li></ul>	<ul style="list-style-type: none"><li>• Less than 35% of overall treatment areas show signs of human and predator access, as compared to reference areas</li><li>• Line of sight is limited to &lt;250 on linear disturbances</li></ul>

\*Adapted from Golder, 2015b

## Protection of Restored Habitat

Restoration projects have a greater likelihood of success when a measure of protection is applied to project sites. Determination and establishment of protections are the responsibility of the province, though it may work with individual proponents to establish them.

## Restoration Data Upload

The Electronic Submission Framework (ESF) allows clients of MFLNRORD to submit data electronically. ESF supports restoration proponents to submit silviculture activities to the provincial tracking application “Reporting Silviculture Updated and Land Status Tracking System” (RESULTS). The application RESULTS has been developed to manage submissions of disturbances and silviculture activities as required by the Forest and Range Practices Act (FRPA). This includes data collected as part of quality control. The ESF enables mapping notations to be linked to report data. The BC Geographic Warehouse (BCGW) stores all data under DataBC which allows users to view data on iMapBC. Data can also be ordered from the Data Distribution Service upon request. Proponents must have a valid [BCeID](#) to access RESULTS and are required to request access to the program by completing an online access request form.<sup>23</sup>

More detailed information on the ESF can be found at these websites:

<https://apps.nrs.gov.bc.ca/ext/esf/submissionWelcome.do>

<https://www.for.gov.bc.ca/his/fta/techspec/index/htm>

<https://www.for.gov.bc.ca/his/ft/techspec/>

There are local authorized service providers and forest professionals across the province who will complete ESF submissions. Contact your local FCBC office to obtain names of providers.

Data submitted must comply with the BC Open Information and Open Data Policy.<sup>24</sup> Submissions for quality control, survival, and establishment surveys are due no later than three months following completion of applicable assessments.

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<sup>23</sup> <https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/silviculture/silviculture-reporting-results>

<sup>24</sup> <https://www2.gov.bc.ca/assets/gov/british-columbians-our-governments/services-policies-for-government/information-management-technology/information-privacy/resources/policies-guidelines/open-information-open-data-policy.pdf>

## Public Awareness

Raising public awareness is an important part of the caribou habitat restoration process. Closing the gap of public awareness will more likely enable voluntary protection of restored habitat from future disturbances, as well as to meet the public's interest by keeping communities informed and educated about ongoing recovery efforts for woodland caribou. While it is a challenge, the following are some recommendations for raising awareness about restoration projects:

- Restoration projects funded through certain non-governmental organizations, such as the Habitat Conservation Trust Foundation (HCTF), may become publicized as part of the foundation's required reporting or education and awareness program. This often includes newsletters, posters, and online resources.
- Signage is encouraged at the site of restoration to inform local communities and visitors of ongoing and completed habitat restoration efforts. In addition, informative habitat restoration signs can be used to educate the public on the decline of woodland caribou, why restoration is important for their recovery, and what is done to complete a project. Signage can discourage trespassing and consequently protect the restored habitat from disturbance. At a minimum, signage should include the project name, the geographic extent of the project, and contact information of the proponent.
- Signage is important to warn the public of roads that have been deactivated or rehabilitated as part of a caribou habitat restoration project and inform them of the importance of growing trees in an undisturbed environment.
- Caribou habitat restoration area maps or shapefiles may be added to existing government databases such as iMapBC. This enables the public to access map layers stored in the BC Geographic Warehouse (BCGW). Within iMapBC, map-based tools such as Habitat Wizard<sup>25</sup> allow for report data (e.g., restoration project summaries) to be linked to map notations.



FIGURE 3: IMAGE OF EXAMPLE SIGNAGE

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<sup>25</sup> <https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/ecosystems/habitatwizard>

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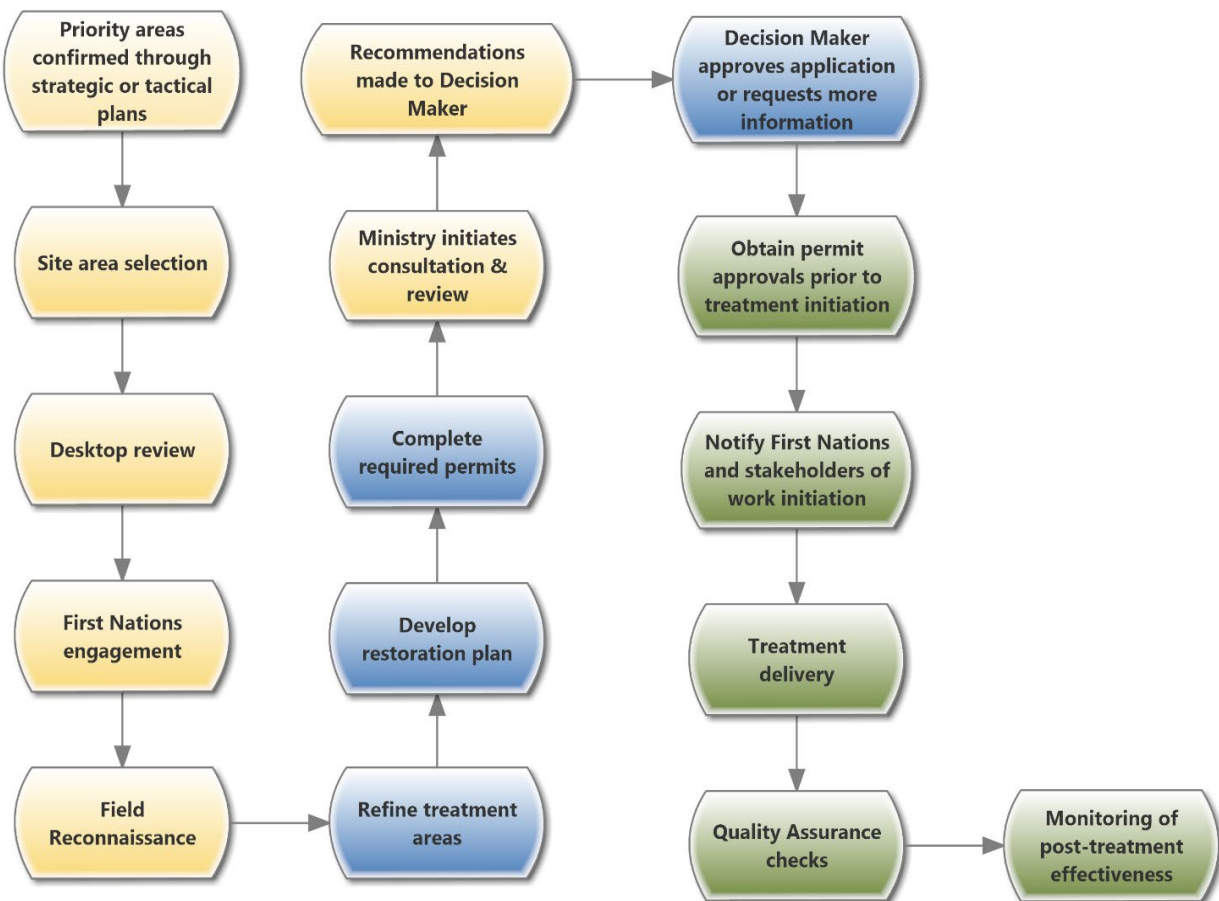
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## Appendix A. Process Flow Diagram

FIGURE 4. FLOWCHART OF FRAMEWORK PLANNING PROCESS.



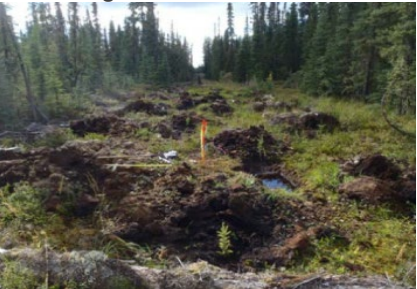


- 1) Priority areas confirmed through strategic or tactical plans → Site area selection → Desktop review (overlapping active and proposed tenures, First Nations, stakeholder groups, limiting factors, access) → First Nation engagement → Field reconnaissance → Local government /stakeholder/tenure holder engagement → Refine treatment areas → Restoration plan development: objectives, treatment zones, treatment techniques, site conditions/characteristics, engagement completed and required permits.

## Appendix A. Process Flow Diagram



- 2) Complete required permit applications (if applicable) with supporting information such as a restoration plan (submitted to relevant provincial ministry for review and approval) → Ministry initiates consultation and review → Recommendations made to Decision Maker – Decision Maker approves or requests more information.
- 3) Obtain permit approvals prior to treatment initiation → Notify First Nations and stakeholders of work initiation → Treatment delivery → Quality assurance checks → Post-treatment effectiveness monitoring (monitoring plan) if a required component of the restoration funding provider.





## Appendix B. Restoration Treatments

Treatment	What is it?	Why? (Purpose)	Where?	Considerations
<p>Mounding</p>  	<p>Mounding involves the creation of mounds by flipping the soil. Using an excavator, holes are dug and the soil is placed beside the hole created an elevated mound.</p>	<p>Mounding improves microsite drainage and aeration on wetter sites and moderates soil temperature and can lengthen the growing season.</p>	<p>Wetter sites and on sites to reduce competition (e.g., from grass).</p>	<p>Recommended height of a mound depends on the parent material, but usually the final setting height should not exceed 20-30cm. Mounding is not always suitable for dry sites. Access and operator experience is crucial as spacing and height of mounds must be suitable for the site conditions.</p>
<p>Image source:  Golder report January 2015. <a href="https://www.bccgc.ca/files/application-manuals/ABA-Guidance/2015golderrestoration-toolkit.pdf">https://www.bccgc.ca/files/application-manuals/ABA-Guidance/2015golderrestoration-toolkit.pdf</a>  Fundamentals of Mechanical Site Preparation, FRDA Report 178, 1992 Forestry Canada and BC Ministry of Forests.  <a href="https://www.for.gov.bc.ca/hfp/publications/00084/FRDA178.pdf">https://www.for.gov.bc.ca/hfp/publications/00084/FRDA178.pdf</a></p>				
<p>Mulching</p> 	<p>Shredding or tearing up vegetation mechanically.</p>	<p>Used to improve forest regeneration. Mulch may help support recruitment of conifers required to convert disturbed areas to forested stands.</p>	<p>Where understory vegetation needs to be cleared to support a restoration objective.</p>	<p>Can be expensive. Existing brush may be creating a form of functional restoration by limiting access.</p>
<p>Image source:  Hydraulic mulching attachment. Digital Image. Jan. 1, 2009. Wikipedia.  <a href="https://en.wikipedia.org/wiki/Forestry_mulching#/media/File:Fecon_hydraulic_mulching_attachment_on_rubber-tired_tractor.jpg">https://en.wikipedia.org/wiki/Forestry_mulching#/media/File:Fecon_hydraulic_mulching_attachment_on_rubber-tired_tractor.jpg</a></p>				



## Appendix B. Restoration Treatments

Treatment	What is it?	Why? (Purpose)	Where?	Considerations
<b>Ripping</b> 	<p>A method used to rip up soil where compaction may be a concern and where erosion risk is low. Ripper plows can be attached on the back of a crawler tractor.</p>	<p>To create plantable spots in wet areas and provide a degree of frost protection for seedlings on drier southern interior sites.</p>	<p>Wet spruce types with thick duff layers and muskeg. Can be used on drier sites in the southern interior.</p>	<p>Prepared during frozen ground conditions. Not recommended on dry sites with thin duff layers, slopes &gt;25% and broken or rugged terrain.</p>
<p>Image source: Silviculture knowledge for reclamation of oil and gas disturbances. Soil decompaction. Natural Resources Canada. 2016 <a href="https://cfs.nrcan.gc.ca/pubwarehouse/pdfs/36968.pdf">https://cfs.nrcan.gc.ca/pubwarehouse/pdfs/36968.pdf</a></p>				
<b>Mixing</b> 	<p>Incorporates surface organic layers with mineral soil.</p>	<p>Treatment leaves the nutrients immediately available for planted seedlings or germinants. Also raises soil temperature and the ability of the surface materials to retain moisture.</p>	<p>Utilize fine mixing on sites that have a high potential for competing vegetation. Spot mix where debris, stumps or other obstacles prohibit strip mixing implements.</p>	<p>May cause long-term depletion of nutrients by making them excessively available in the first few years after treatment. Mixing only the planting spots avoids this. Inadequate mixing can stimulate competing vegetation.</p>
<p>Image source: Fundamentals of Mechanical Site Preparation, FRDA Report 178, 1992 Forestry Canada and BC Ministry of Forests. <a href="https://www.for.gov.bc.ca/hfp/publications/00084/FRDA178.pdf">https://www.for.gov.bc.ca/hfp/publications/00084/FRDA178.pdf</a></p>				



## Appendix B. Restoration Treatments

Treatment	What is it?	Why? (Purpose)	Where?	Considerations
<b>Scalping</b> 	<p>Surface organic layers are removed in patches or continuous strips to expose mineral soil.</p>	<p>To expose mineral soil that warms faster than undisturbed soil beneath insulating organic layers. Can also provide microsites for seed germination and establishment.</p>	<p>Most suitable on well drained sites with medium textured soils. Creates a range of planting spots.</p>	<p>Avoid scalping too deep or too wide, especially on nutrient-poor sites that have a thin humus layer. Not recommended on wet sites. Fine textured, compacted subsurface soil exposed in scalps may restrict seedling root growth.</p>
<p>Image source:            Scalping landscape. Digital Image. Feb. 20, 2021. <a href="https://www.ecogroundworks.ca/services/site-preparation/">https://www.ecogroundworks.ca/services/site-preparation/</a>            Fundamentals of Mechanical Site Preparation, FRDA Report 178, 1992 Forestry Canada and BC Ministry of Forests.  <a href="https://www.for.gov.bc.ca/hfp/publications/00084/FRDA178.pdf">https://www.for.gov.bc.ca/hfp/publications/00084/FRDA178.pdf</a></p>				
<b>Disc Trenching</b> 	<p>Continuous or intermittent furrows or trenches.</p>	<p>Mixes soil and humus in a way that favours growth while also providing micro-relief needed for the successful establishment of seedlings.</p>	<p>Most suitable for moist (not wet) conditions where cold wet patches are interspersed with areas of better drainage.</p>	<p>Not recommended for cold and wet or steep sites, on rangeland or on sloped sites where erosion from water channelling is a concern.</p>
<p>Image source:            Disc trenching attachment. Digital Image. Feb. 20, 2021. AgriExpo. <a href="https://www.agriexpo.online/prod/fsi-franskan/product-175275-90914.html">https://www.agriexpo.online/prod/fsi-franskan/product-175275-90914.html</a></p>				

## Appendix B. Restoration Treatments



Treatment	What is it?	Why? (Purpose)	Where?	Considerations
<b>Scarification</b> 	Where surface organic layers are removed to expose and loosen mineral soil.	Creates suitable seedbeds, distributes seed material, promotes faster development of root systems of a planted seedling and promotes the release of seeds from serotinous cones when temperatures are high enough.	Where vegetative competition is low, where there is a seed source from adjacent forests and where cones are present on the ground after a disturbance.	Does not provide adequate vegetation control where competition is high. Not appropriate for very wet or very dry sites. Avoid extensive removal of organic material. Suitable where light site preparation is required (thin dry humus types).
Image source: Site Preparation for Restoring Forest Cover on Oil and Gas Sites. Natural Resources Canada. 2019. <a href="https://www.360tours.cosia.ca/toolkit/">https://www.360tours.cosia.ca/toolkit/</a>				
<b>Spreading of woody debris</b> 	Functional restoration tool where woody debris is spread at varying densities on a linear feature.	Access control method and/or prepare a site for natural regeneration or planting.	Linear features where woody debris is available.	If natural regeneration is the recovery method, woody material volume should not exceed 99 tonnes/ha. If ATV access control is being sought, larger volumes will be required. District fire officers should be consulted to determine the best method to avoid creating a fire hazard.
Image source: Golder report January 2015. <a href="https://www.bcogc.ca/files/application-manuals/ABA-Guidance/2015golderrestoration-toolkit.pdf">https://www.bcogc.ca/files/application-manuals/ABA-Guidance/2015golderrestoration-toolkit.pdf</a>				

## Appendix B. Restoration Treatments



Treatment	What is it?	Why? (Purpose)	Where?	Considerations
<b>Tree Felling and Bending</b> 	Strategically fall trees across a linear corridor.	Control access by predators and humans along a linear feature.	Linear feature where there is sufficient timber that will fall across the corridor.	Works best where a linear feature is relatively narrow and have a relatively dense adjacent forest cover. Larger diameter trees work best. Fall trees at 15-20m intervals.
Image source: Golder report January 2015. <a href="https://www.bccgc.ca/files/application-manuals/ABA-Guidance/2015golderrestoration-toolkit.pdf">https://www.bccgc.ca/files/application-manuals/ABA-Guidance/2015golderrestoration-toolkit.pdf</a>				
<b>Fence Installation</b> 	Block linear features with modified structures.	To control human and predator access on linear features and reduce line-of-sight (to decrease hunting success).	On linear features where natural topography and existing vegetation are not blocking the line-of-sight.	Make fences from decomposable materials such as rough, untreated lumber. Construct in panels and haul to the sites where the panels are fastened together to create fences. Install gates where human access needed for safety purposes.
Image source: Golder report January 2015. <a href="https://www.bccgc.ca/files/application-manuals/ABA-Guidance/2015golderrestoration-toolkit.pdf">https://www.bccgc.ca/files/application-manuals/ABA-Guidance/2015golderrestoration-toolkit.pdf</a>				



## Appendix B. Restoration Treatments

Treatment	What is it?	Why? (Purpose)	Where?	Considerations
<b>Seeding/shrub planting</b> 	Reliable method to ensure the establishment of a target species at a desired density.	Establish a specific species on a site.	Microsites that support seedling development.	Survival and reliability are better than natural regeneration. Planning in advance is required to order appropriate stock, transport planting stock and hire crews to plant stock.
Image source: Tree replanting. Digital Image. Sherwood Forests.com. Feb. 20, 2021. <a href="https://sherwoods-forests.com/Inventory/Inventory.html">https://sherwoods-forests.com/Inventory/Inventory.html</a>				
<b>Natural Regeneration</b> 	Low-cost regeneration method providing favourable environmental conditions exist to support this method of regeneration.	Regenerate disturbed site with natural species.	Where natural propagule supply is available or seed source from target tree species surrounding the site available. Different species will have different environmental condition requirements for natural regeneration.	Low cost, but higher risk than seedling planting. Specific site conditions must be met to achieve natural regeneration. Better on smaller minimally disturbed sites.
Image source: Regeneration Techniques for Restoring Forest Cover on Oil and Gas Sites. Natural Resources Canada. 2019. <a href="https://www.360tours.cosia.ca/toolkit/">https://www.360tours.cosia.ca/toolkit/</a>				

## Appendix B. Restoration Treatments

Treatment	What is it?	Why? (Purpose)	Where?	Considerations
<b>Tree/shrub Transplanting</b> 	Transplanting established trees and shrubs from one location to another.	Reduces time to sow seed stock in a nursery. Trees and shrubs are larger and will take less time to establish on a site.	Best on smaller sites where restoration target can be met faster by planting larger trees and shrubs.	Expensive (due to labour intensive work) and requires proper timing and techniques to ensure trees/shrubs survive the transplant.
Image source: Vegetation Management for Restoring Forest Cover on Oil and Gas Sites. Natural Resources Canada. 2019. <a href="https://www.360tours.cosia.ca/toolkit/">https://www.360tours.cosia.ca/toolkit/</a>				
<b>Lichen Transplanting</b> 	Caribou are diet specialists utilizing lichen-rich habitat for forage during winter months.	To restore terrestrial lichen communities in wildlife and other disturbed caribou winter habitat.	Wildfire burns in high value caribou winter habitat.	Consider collecting lichen from approved disturbance footprints. Avoid collecting within known caribou habitat and critical habitat areas. Areas where snow depth limits forage are also high potential collection areas.
Image source: Examining the role of terrestrial lichen transplants in restoring woodland caribou winter habitat. S. Rapai, McColl D, McMullin R. 2017, Vol 93, No 3. The Forestry Chronical.				



Appendix B. Restoration Treatments



FIGURE 5. TYPICAL FACTORS THAT CAN LIMIT PLANT GROWTH ON RECLAIMED SITES.<sup>26</sup>



\*Note: the indicated techniques may alleviate competition by exposing microsites, but these microsites may lead to increased competition if a vegetation management plan is not in place.

FIGURE 6. SITE PREPARATION TECHNIQUES AND THE LIMITING FACTORS THEY ADDRESS.<sup>27</sup>

<sup>26</sup> Natural Resources Canada 2017. A guide to Site Preparation.  
<sup>27</sup> Natural Resources Canada 2017. A guide to Site Preparation.

## Appendix C. Restoration Plan Checklist

KEY ITEM	REQUIRED DETAIL	COMPLETED
PROJECT IDENTIFICATION AND OBJECTIVES	<ul style="list-style-type: none"> <li>General tenure information</li> <li>Caribou herd</li> <li>Restoration objectives</li> </ul>	<input type="checkbox"/>
SITE MAPS	<ul style="list-style-type: none"> <li>Treatment Map(s) depicting treatment units, streams, roads and relevant layers (1:10,000)</li> <li>General Site Location Map and access routes</li> </ul>	<input type="checkbox"/>
PERMITTING and AUTHORIZATIONS	<ul style="list-style-type: none"> <li>Written understanding of relevant regulations and statutes</li> <li>Acquisition of approvals or permit applications based on project activities and verified environmental features</li> </ul>	<input type="checkbox"/>
ENGAGEMENT	<ul style="list-style-type: none"> <li>Summary of stakeholder (e.g., government, other tenure holders) and First Nation engagement and results</li> </ul>	<input type="checkbox"/>
MANAGEMENT PRACTICES	<ul style="list-style-type: none"> <li>Summary of existing site conditions based on field survey (e.g., vegetation, streams)</li> <li>Summary of environmental setting based on online background search (e.g., sensitive plant, wildlife features, fisheries resources, timing windows)</li> <li>Written understanding of applicable mitigation and conservation measures as required by regulation and best management practices</li> <li>Summary of procedures to be implemented (e.g., stream crossings, erosion and sediment control, invasive plant management, spill prevention)</li> </ul>	<input type="checkbox"/>
TREATMENT AREA SUMMARY	<ul style="list-style-type: none"> <li>Description of how areas were classified to be treated, not treated, or left for natural regeneration</li> <li>Outline of restoration techniques to be applied (e.g., mechanical site preparation, planting, access control)</li> <li>Outline of how prescriptions were chosen based on site conditions and site limiting factors</li> <li>Summary treatment table for individual treatment zones</li> </ul>	<input type="checkbox"/>
ACCESS	<ul style="list-style-type: none"> <li>Pre and post treatment access considerations</li> </ul>	<input type="checkbox"/>
MONITORING PLAN	<ul style="list-style-type: none"> <li>Plan to collect information post treatment where applicable</li> </ul>	<input type="checkbox"/>
OTHER CONSIDERATIONS	<ul style="list-style-type: none"> <li>Worker safety</li> <li>Worker training and availability of equipment</li> </ul>	<input type="checkbox"/>

## Appendix D. Restoration Plan and Map Example

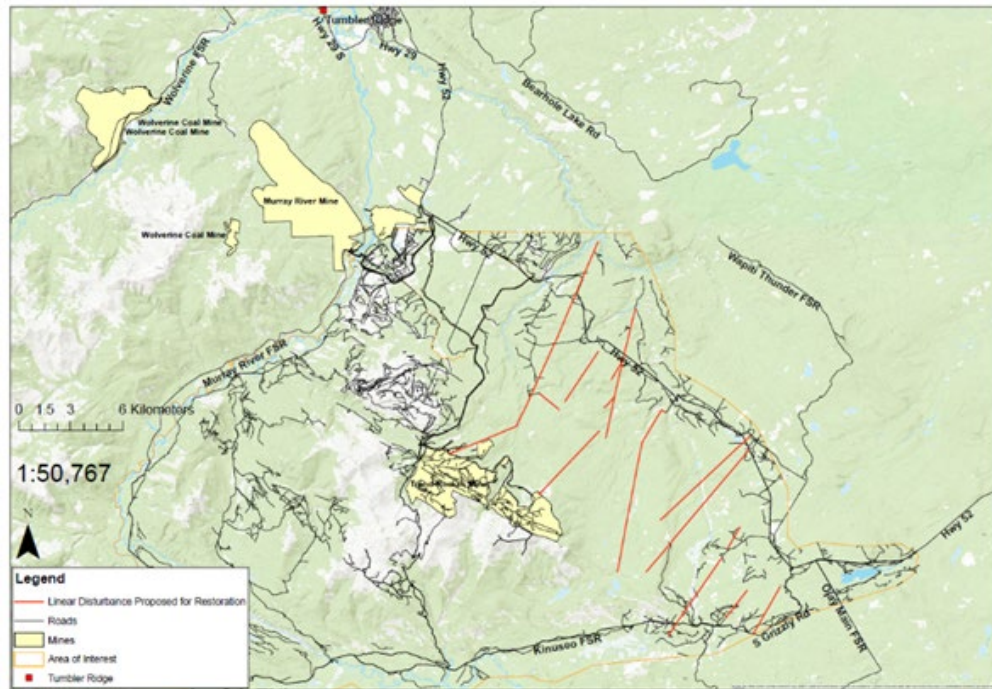
PROJECT IDENTIFICATION							
TSA	FOREST DISTRICT	TENURE HOLDERS			LOCATION (UTM)		
GEOGRAPHIC LOCATION	ROAD PERMITS	CLIENT NAME(S)					
CARIBOU HERD							
PROJECT OBJECTIVES							
MECHANICAL SITE PREPARATION OBJECTIVES							
SILVICULTURE OBJECTIVES							
FOREST PRACTICES CODE OF BRITISH COLUMBIA ACT							
ACTIVITY/PRACTICE	SECTION	HOW IT APPLIES					
FOREST AND RANGE PRACTICES ACT							
ACTIVITY/PRACTICE	SECTION	HOW IT APPLIES					
OTHER ACTS AND REGULATIONS							
ACTIVITY/PRACTICE	SECTION	HOW IT APPLIES					
OTHER VALUES							
First Nations							
Trappers/Guides							
MANAGEMENT PRACTICES							
Invasive plants							
Wildlife							
Soils							
Riparian Areas							
Treatment Unit	Area/Length	UTMs	Zone/Subzone/Variant/Phase	Site Series	Elevation	Soil Texture	Rooting Depth
Site Characteristics							
Age							
% Cover							
% CWD							
Height							
Lichen Cover							
Species							

## Appendix D. Restoration Plan and Map Example

<b>SPH</b>			
<b>Successional STAGE</b>			
<b>Proposed Treatment</b>			
<b>Monitoring plan</b>			
<b>SAMPLING DESIGN</b>			
<b>Survey Types (Survival/Establishment)</b>			
<b>Plot Design</b>			
<b>Data Collection</b>			
<b>Data Analysis</b>			
<b>Restoration Targets</b>			
<b>Restoration Goal</b>	<b>Evaluation Criteria/Indicators</b>	<b>Targets</b>	

<b>Site Photographs</b>

## Appendix D. Restoration Plan and Map Example



## Appendix E. BC Data Catalogue Layers

Data layers can be found here: [www.gov.bc.ca](http://www.gov.bc.ca)

Some of the layers noted below only show active applications or tenures. Some of the layers show **expired, cancelled, inactive, etc.** areas as well, but not all. **Care needs to be taken when looking at these layers so that the appropriate information is extracted.** If, however, these layers are to be used to exclude areas for treatment, the same caveat applies.

The BC Oil and Gas Commission (OGC) should be consulted directly for guidance with their data and/or have them query acceptable candidate areas.

**Caution:** The OGC road features have the name of the company the permit is/was issued to, but the roads are not all active

- Oil and gas tenure holders –tenure holder information may not be provided
  - Petroleum Roads
  - WHSE\_MINERAL\_TENURE.OG\_ROAD\_AREA\_PERMIT\_SP
  - WHSE\_MINERAL\_TENURE.OG\_PETRLM\_DEV\_RDS\_PRE06\_GOV\_SP
  - Well Sites
  - WHSE\_MINERAL\_TENURE.OG\_WELL\_FACILITY\_PERMIT\_SP
  - Pipeline Rights-of-Way
  - WHSE\_MINERAL\_TENURE.OG\_PIPELINE\_AREA\_PERMIT\_SP
  - Geophysical
  - WHSE\_MINERAL\_TENURE.OG\_GEOPHYSICAL\_PERMIT\_SP
  - Facility Sites
  - WHSE\_MINERAL\_TENURE.OG\_FACILITY\_LOCATNS\_PERMIT\_SP
  - WHSE\_MINERAL\_TENURE.OG\_FACILITY\_LOCATNS\_PRE2016\_SP
  - Ancillary Sites
  - WHSE\_MINERAL\_TENURE.OG\_ASSOC\_ANCILLARY\_PERMIT\_SP
- Mining tenures
  - <https://catalogue.data.gov.bc.ca/dataset/permitted-mine-areas-major-mine>
  - WHSE\_MINERAL\_TENURE.HSP\_MJR\_MINES\_PERMTD\_AREAS\_SP
  - WHSE\_MINERAL\_TENURE.MTA\_ACQUIRED\_TENURE\_GOV\_SVW
  - Not all “mines” have MEM spatial data, but do have NOWs
  - WHSE\_MINERAL\_TENURE.MMS\_NOTICE\_OF\_WORK

Wind investigative areas are rather large at times, but the footprint is actually very small until they get into the development of the farm, which requires a new set of land and possibly forest tenures. Investigative permit areas may not be very significant at this stage.

- Wind investigative tenures
  - <https://catalogue.data.gov.bc.ca/dataset/tantalis-crown-tenures>  
**WHSE\_TANTALIS.TA\_CROWN\_TENURES\_SVW**
  - **Query:** TENURE\_SUBTYPE = 'INVESTIGATIVE LICENCE' and TENURE\_PURPOSE = 'WINDPOWER'
  - Could also use WHSE\_TANTALIS.TA\_CROWN\_LICENSES\_SVW (one less layer for contract). Query is true in both cases.
  - For all the wind power tenures in this region the legal description starts with “Investigate Area” for the investigative area and it starts with “Site” for the meteorological tower sites. They are multiple parcels under the same tenure.
  - **Query:** TENURE\_LEGAL\_DESCRIPTION LIKE 'Investigative Area%'
- Land Act Licences of Occupation
  - <https://catalogue.data.gov.bc.ca/dataset/tantalis-crown-land-licenses>  
**WHSE\_TANTALIS.TA\_CROWN\_LICENSES\_SVW**
  - **Query:** TENURE\_SUBTYPE = 'LICENCE OF OCCUPATION'
- Road tenures or permit for primary user details. **Caution** – uncertainties of what level of detail exists for industrial roads
  - <https://catalogue.data.gov.bc.ca/dataset/forest-tenure-road-section-lines>  
**WHSE\_FOREST\_TENURE.FTEN\_ROAD\_SECTION\_LINES\_SVW**
  - As with OGC roads, the licensee is in the data, but that doesn’t necessarily mean that’s the primary user (although it usually is).
- Agricultural Land Reserve
  - <https://catalogue.data.gov.bc.ca/dataset/alc-agricultural-land-reserve-lines>  
**WHSE\_LEGAL\_ADMIN\_BOUNDARIES.OATS\_ALR\_BOUNDARY\_LINES\_SVW**
- TSA and TFL boundaries
  - <https://catalogue.data.gov.bc.ca/dataset/fadm-timber-supply-area-tsa>  
**WHSE\_ADMIN\_BOUNDARIES.FADM\_TSA**
  - <https://catalogue.data.gov.bc.ca/dataset/fadm-tree-farm-license-current-view-tfl>  
**WHSE\_ADMIN\_BOUNDARIES.FADM\_TFL\_ALL\_SP**
- Woodlots
  - <https://catalogue.data.gov.bc.ca/dataset/forest-tenure-managed-licence>  
**WHSE\_FOREST\_TENURE.FTEN\_MANAGED\_LICENCE\_POLY\_SVW**
  - **Query:** FOREST\_FILE\_ID LIKE 'W%'
- Range tenure holders
  - <https://catalogue.data.gov.bc.ca/dataset/range-tenure>  
**WHSE\_FOREST\_TENURE.FTEN\_RANGE\_POLY\_SVW**



- Municipal or regional district boundaries
  - <https://catalogue.data.gov.bc.ca/dataset/tantalismunicipalities>  
**WHSE\_TANTALIS.TA\_MUNICIPALITIES\_SVW**
  - <https://catalogue.data.gov.bc.ca/dataset/tantalisregionaldistricts>  
**WHSE\_TANTALIS.TA\_REGIONAL\_DISTRICTS\_SVW**
- Private/Crown (Tantalus)
  - ParcelMapBC: <https://catalogue.data.gov.bc.ca/dataset/parcelmap-bc-parcel-fabric>  
**WHSE\_CADASTRE.PMBC\_PARCEL\_FABRIC\_POLY\_SVW**
- Trapper and Guide Outfitter
  - Traplines: <https://catalogue.data.gov.bc.ca/dataset/traplines-of-british-columbia>  
**WHSE\_WILDLIFE\_MANAGEMENT.WAA\_TRAPLINE\_AREAS\_SP**
  - Guide Outfitters: <https://catalogue.data.gov.bc.ca/dataset/guide-outfitter-areas>  
**WHSE\_WILDLIFE\_MANAGEMENT.WAA\_GUIDE\_OUTFITTER\_AREA\_SVW**

## Appendix F. Data Collection Protocols and References

### Effectiveness Monitoring Data Collection Standard Protocols.<sup>28</sup>

#### Measurable Target Data Collection Procedures

Measurable Target	Description of data collection method	Reference
BEC zone, subzone, site series	Describe the Biogeoclimactic zone, subzone and site series of the plot using the Ministry of Forests and Range maps and regional field guide to site identification and interpretation for terrestrial zones (available online) and the Wetlands of British Columbia to describe wetland ecosystems.	BC MoFLNRO 2011; MacKenzie and Moran 2004
Slope	Record percent slope gradient using a clinometer.	BC MoFR and BC MoE 2010 (Section 1 page 25)
Aspect	Record orientation of slope relative to true north, using a compass.	BC MoFR and BC MoE 2010 (Section 1 page 25)
Mesoslope position	Record the position of plot relative to localized catchment area using codes, where: CR = crest UP = upper slope MB = middle slope LW = lower slope TO = toe DP = depression LV = level GU = gully	BC MoFR and BC MoE 2010 (Figure 1.3, Section 1 page 25-26)
Elevation	Determine in the field using an altimeter or GPS at plot center. Record in meters.	BC MoFR and BC MoE 2010 (Section 1 page 25)
Soil Organic depth	Record the depth of the upper and lower boundaries of the organic layer (in centimetres) at plot center.	BC MoFR and BC MoE 2010 (Section 2, page 28)
Mottles/gley depth	Describe whether there is iron oxidation in the soil and if so, measure the depth at plot center.	BC MoFR and BC MoE 2010 (Section 2 page 45)
Soil surface/effective texture	Describe the texture of the soil within the A horizon using soil classification codes in the Canada Soil Information System.	Expert Committee on Soil Survey 1982

<sup>28</sup> From Golder Boreal Caribou Habitat Restoration Monitoring Framework 2015 Report 1529986-001

## Appendix F. Data Collection Protocols and References

Soil class	Use the Canadian System of Soil Classification codes for soil order, great groups and subgroups.	BC MoFR and BC MoE 2010 (Section 2 page 14 and Sections 9.17 and 9.18)
Drainage Class	Assess the speed and extent of water removal from the soil in growing season conditions using Drainage class codes, where: <ul style="list-style-type: none"> <li>• x = very rapidly drained</li> <li>• r = rapidly drained</li> <li>• w = well drained</li> <li>• m = moderately well drained</li> <li>• i = imperfectly drained</li> <li>• p = poorly drained</li> <li>• v = very poorly drained</li> </ul>	BC MoFR and BC MoE 2010 (Table 2.16, Section 2 page 22)
Soil moisture regime	Assess the soil moisture based on environmental factors, soil properties and indicator plants. Use code system 0 to 8, where: <ul style="list-style-type: none"> <li>• 0 = very xeric</li> <li>• 1 = xeric</li> <li>• 2 = subxeric</li> <li>• 3 = submesic</li> <li>• 4 = mesic</li> <li>• 5 = subhygric</li> <li>• 6 = hygric</li> <li>• 7 = subhydric</li> <li>• 8 = hydric</li> </ul>	BC MoFR and BC MoE 2010 (Table 1.1., Section 1 page 13)
Nutrient regime	Assess the nutrient regime based on environmental factors, soil properties and indicator plants. Use code system A to F, where: <ul style="list-style-type: none"> <li>• A = very poor</li> <li>• B = poor</li> <li>• C = medium</li> <li>• D = rich</li> <li>• E = very rich</li> <li>• F = saline</li> </ul>	BC MoFR and BC MoE 2010 (Table 1.2, Section 1 page 15)
Type of disturbance	Describe the type of linear disturbance, (e.g., seismic line, cutline, trail, pipeline, transmission line, road, or other).	n/a
Line/trail width	Record the width of each linear disturbance by measuring a straight line from one distinguishable linear edge to another at plot centre. As a general rule, edges can be determined to start at the first mature tree (DBH > 10 cm) from the disturbed area. Record measurement of the linear disturbance in meters.	Oberg 2001
Age of line	Approximate age based on vegetation regrowth (refer to age of trees in treatment /reference plot) or known age based on disturbance marker such as a seismic tag; use age categories of < 5 years, 5 - 10 years, 10 - 20 years, 20 - 40 years and > 40 years.	To estimate using age of trees in plots: BC MoFLRNO 2015a (Figure 4.15)
Line orientation	Record the orientation that the linear disturbance runs using a compass (in degrees).	n/a
Line of sight distance	Estimate distance that observer can visually see down the linear disturbance (both directions) with bare eye (in meters). One observer stands at plot center while other field crew member walks down line until observer can no longer see them. Classify distances as < 50 m, 50 – 200 m, 200 – 500 m and > 500 m.	Switalski and Nelson 2011

## Appendix F. Data Collection Protocols and References

Average height and vertical density of standing vegetation	<p>Using robel poles, this measurement method can determine amount of standing vegetation remaining on an area after use and can be interpreted as the hiding cover for wildlife. This method can be used to monitor height and vertical density of standing vegetation over large areas quickly.</p> <p>Place the robel pole 5 m from the plot center in the middle of the line along each orientation of the linear disturbance (e.g., 90 degrees and 270 degrees if that is the orientation of the line). Observer crouches so their eye level is at 1 m, to visually assess the band on the pole that is at the top of the vegetation and records the height. Two measurements should be taken (in centimeters) and an average recorded (in meters) for each orientation of the linear disturbance (Robel 1 and Robel 2).</p>	Robel et al. 1970
Evidence of human line use	<p>Assess whether there has been evidence of human use on the linear disturbance. If so, add information about whether it is motorized or foot traffic. Assess access level using the following categories: absent, low (tracks/ trail evident but difficult to discern or appear to be used infrequently), or high (tracks / trail evident and appear to be well used; vegetation is trampled and bare ground may be visible).</p>	NGTL 2014
Evidence of game trail	<p>Assess linear disturbance for evidence of wildlife game trail. Game trail is defined as wildlife walking on a trail that is embedded in a path on the ground due to animals walking the same route for many years. Assess access level using the following categories:</p> <ul style="list-style-type: none"> <li>• absent</li> <li>• low: tracks/ trail evident but difficult to discern or appear to be used infrequently</li> <li>• high: tracks / trail evident and appear to be well used; vegetation is trampled and bare ground may be visible.</li> </ul>	BC MoFR and BC MoE 2010 (Section 5, Table 5.11)
Wildlife sign	<p>Search the area and record any sign of scat, tracks, trails, tunnels, nests/beds/burrows/dens, signs on compacted or foraged vegetation and wildlife remains.</p>	Numerous references for determining wildlife signs, e.g., Elbroch 2003
Percent cover of non-living and organic matter	<p>Record the proportion of ground surface covered by each substrate class of non-living and organic matter (water, mineral soil, cobbles and stones, bedrock, decaying wood and organic matter); needs to add up to 100% within plot.</p> <p>See Figure 3.2 in BC MoFR and BC MoE 2010 for visual estimation of foliage coverage.</p>	BC MoFR and BC MoE 2010 (Figure 3.2)
Height of trees in treatment/reference plots	<p>Measure and record total height of individual trees in centimetres, by measuring the length of the tree along the stem from high side ground. Record by tree species type.</p>	BC MoFLRNO 2015a (page 86)
Root collar diameter (rcd) of trees in treatment/reference plots	<p>Measure diameter of the stem 1 cm below cotyledon nodes and below any obvious swelling. An average of two measurements should be taken for each tree located within the treatment/reference plot.</p>	BC MoFLNRO 2014
Age of trees in treatment/reference plots	<p>Count the number of whorls present on coniferous trees present within the plot. Record age by species type.</p>	BC MoFLRNO 2015a (Figure 4.15)

## Appendix F. Data Collection Protocols and References

Leader growth (cm)	Measure height of leader for current year, one year prior to data collection and two years prior to data collection. Measurement should be made from the point of germination to the top of the terminal bud of the dominant leader. Record leader growth by tree species type.	BC MoFLRNO 2015b (page 86)
Percent cover of vegetation and invasive/non-native species in treatment/reference plot	Record percentage of the ground surface covered within plot when the crowns are projected vertically, for each vegetation type: Tree/Tall shrub, shrub, forb, graminoid, bryophyte, lichen. See Figure 3.2 in BC MoFR and BC MoE 2010 for visual estimation of foliage coverage.	BC MoFR and BC MoE 2010 (Section 3 page 8 - 10; Figure 3.2)
Density of vegetation in treatment/reference plot	Density class determined through a fixed plot area, using classifications: <ul style="list-style-type: none"> <li>• low: 1 – 1000 stems/ha</li> <li>• medium: 1,001 - 2000 stems/ha</li> <li>• high: 2,001 - 5000 stems/ha</li> <li>• dense: &gt; 5,000 stems/ha.</li> </ul>	AESRD 2015
Soil litter layers description	Dig a soil pit and record the average depths of the L, F and H soil horizons (in centimeters).	BC MoFR and BC MoE 2010 (Section 2, page 25-28; Table 2.20)
Survival of planted seedlings	Record the number of live and dead seedlings within the plot, where live = “trees have enough foliage to keep them alive (live cambium is present) and are rooted into the ground” and dead = “trees are obviously dead, or roots are separated from the ground”.	BC MoFLNRO 2015a (Table 4.2)
Vigour of planted seedlings	Describe general condition of seedlings using classification system 0 to 4, where: <ul style="list-style-type: none"> <li>• 0 = dead</li> <li>• 1 = poor; yellow</li> <li>• 2 = fair; pale green</li> <li>• 3 = good; green</li> <li>• 4 = excellent; dark green</li> </ul>	BC MoFR and BC MoE 2010; Haase 2008

## Appendix G. Habitat Restoration Monitoring Plot Establishment Datasheet

**Note:** These datasheets have been obtained and adapted from (Government of Alberta, 2017) and (Golder, 2015b) to serve as examples. Actual data collection requirements may vary depending on project activities and site conditions; the Proponent must receive approval from the MFLNRORD prior to survey.

The following is an example of a chart to plot Habitat Restoration Monitoring Plot Establishment:

General Plot Information					
Project No.	Plot ID	Date (dd/mmm/yy)	Company	Crew Initials	QAQC initials
Plot Type		Plot Center Coordinates			
<input type="checkbox"/> Treatment <input type="checkbox"/> Reference		Datum	UTM E	UTM N	UTM Zone
		<input type="checkbox"/> NAD 27 <input type="checkbox"/> NAD 83			
Plot center staked?	Disturbance boundary staked?	Plot Markers		Plot Photos	
Y / N	Y / N	Flagging tape Y / N	Aluminum tags Y / N		
General Location Description					
General Location Drawing (include plot markers, adjacent habitat features, disturbances, etc.)					

# Appendix G. Habitat Restoration Monitoring Plot Establishment Datasheet

BEC Zone/ Subzone/ Site Series		BEC Site Series Name		General Vegetation Classification							
				<input type="checkbox"/> Upland Pine <input type="checkbox"/> Upland Decid. <input type="checkbox"/> Upland Spruce <input type="checkbox"/> Wetland Sb-Lt <input type="checkbox"/> Other							
Slope (%)	Aspect (°)	Mesoslope Position						Elevation (m)			
		CR -crest UP -upper MD -middle LW -lower TO -toe DP -depression LV -level GU -gully									
Disturbances		Soil Information									
Human		Soil Org. Depth (cm)	Mottles / Gley (depth)		Surface/Effective Texture		Soil Class	Drainage			
Fire / snow			Y / N cm								
Wildlife		Moisture Regime									
Notes		0-very xeric 1-xeric 2-subxeric 3-submesic 4-mesic 5-subhygric 6-hygric 7-subhygric 8-hydric									
		Nutrient Regime									
		A - very poor B - poor C - medium D - rich E - very rich F - saline									
Linear Feature Information											
Type of Linear Disturbance								Comments			
<input type="checkbox"/> Seismic line <input type="checkbox"/> Cutline <input type="checkbox"/> Trail <input type="checkbox"/> Pipeline <input type="checkbox"/> Transmission line <input type="checkbox"/> Road <input type="checkbox"/> Other											
Line Width (m)	Line Age Class (years)			Line-of-Site Distance Class (m)				Line Orientation			
	<input type="checkbox"/> <5 <input type="checkbox"/> 5-10 <input type="checkbox"/> 10-20 <input type="checkbox"/> 20-40			<input type="checkbox"/> <50 <input type="checkbox"/> 50 - 200 <input type="checkbox"/> 200 - 500 <input type="checkbox"/> > 500							
Robel	Height (cm)	Bearing	Photo #	Adjacent Site Series /Tree Canopy Attributes		Adjacent (NE)		Adjacent (SW)			
1				BEC zone/ subzone/ site series							
2				Overstory / Understory canopy							
Evidence of Line Use by Humans				Evidence of Line Use by Wildlife							
<input type="checkbox"/> none <input type="checkbox"/> ATV <input type="checkbox"/> Truck <input type="checkbox"/> Heavy Machinery Other: _____				<input type="checkbox"/> none <input type="checkbox"/> scat(s) <input type="checkbox"/> track(s) <input type="checkbox"/> game trail(s) <input type="checkbox"/> nest(s) <input type="checkbox"/> other: _____							
Notes re. human evidence of line use, including estimated amount of use:				Notes re. wildlife evidence of line use, including estimated amount of use:							
Surface Substrate - % cover of non-living matter; adds to 100% within plot											
Water		Mineral Soil		Cobbles & Stones		Bedrock		Decaying Wood		Organic Matter	
Treatment Plot Information											
Treatment Type			Stocking Density		Stock type (of planted species)			Year of Treatment		Plot Radius	
Species	planted (P) / Nat. Regen (N)	Ht (cm)	Leader Growth (cm) 1st / 2nd / 3rd year #	rcd (cm)*^	age^	Species	planted (P) / Nat. Regen (N)	Ht (cm)	Leader Growth (cm) 1st / 2nd / 3rd year #	rcd (cm)*^	age^

# 1st year refers to the current year; 2nd year refers to one year since time of data collection; 3rd year refers to 2 years from time of data collection  
 \* root collar diameter; ^ recorded only for tallest individual of each species

# Appendix G. Habitat Restoration Monitoring Plot Establishment Datasheet

Vegetation Cover - within plot					
Tree/ Tall Shrub [T] (1.5 - 4.9 m)	Shrub [S] (<1.5 m)	Forb [F]	Graminoid [G]	Bryophyte [B]	Lichen [L]
+ 1 2 3 4 5 6 7 8	+ 1 2 3 4 5 6 7 8	+ 1 2 3 4 5 6 7 8	+ 1 2 3 4 5 6 7 8	+ 1 2 3 4 5 6 7 8	+ 1 2 3 4 5 6 7 8
Dominant and Co-dominant plant Species					
Species	Strata	Cover Class	Species	Strata	Cover Class
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
Incidental Wildlife Observations					
Species	Sign		Notes / Comments		
1					
2					
3					
4					
5					
Comments / Notes					

Cover classes: + [<1%], 1 [1-2%], 2 [>2-5%], 3 [>5-10%], 4 [>10-25%], 5 [>25-50%], 6 [>50-75%]



## Appendix H. Ground-based Habitat Restoration Monitoring Survey Datasheet

### Effectiveness Monitoring Data Sheets

**Note:** These datasheets have been obtained and adapted from (Government of Alberta, 2017) and (Golder, 2015b) to serve as examples. Actual data collection requirements may vary depending on project activities and site conditions; the Proponent must receive approval from the MFLNRORD prior to survey.

**FIGURE 7. EXAMPLE OF GROUND-BASED HABITAT RESTORATION MONITORING SURVEY.**

\* root collar diameter: ^ recorded only for tallest individual of each species

# Appendix H. Ground-based Habitat Restoration Monitoring Survey Datasheet

Vegetation Percent Cover - average within plot					
Tree/Tall Shrub [T]	Shrub [S] (<1.5 m)	Forb [F]	Graminoid [G]	Bryophyte [B]	Lichen [L]
+ 1 2 3 4 5 6 7 8	+ 1 2 3 4 5 6 7 8	+ 1 2 3 4 5 6 7 8	+ 1 2 3 4 5 6 7 8	+ 1 2 3 4 5 6 7 8	+ 1 2 3 4 5 6 7 8
Percent Cover of Invasive/Non-Native Species		Description of Invasive/Non-Native Species	Description of Soil Litter Layers		
+ 1 2 3 4 5 6 7 8			L F H O		
Vegetation Density - average within plot					
Tree/Tall Shrub [T] (1.5 - 4.9 m)	Shrub [S] (<1.5 m)	Forb [F] - description of distribution	Graminoid [G] - description of	Bryophyte [B] - description of distribution	Lichen [L] - description of distribution
Low Med High Dense	Low Med High Dense	Low Med High Dense	Low Med High Dense	Low Med High Dense	Low Med High Dense
planted and Naturally Re-established Seedlings - average within treatment plot					
Mounded	Season planted	% Survival		Vigour	
Y / N	Winter / Summer	# of live seedlings: _____ # of dead seedlings: _____		0 - dead    1 - poor    2 - fair    3 - good    4 - excellent	
Dominant and Co-dominant plant Species					
Species	Strata	Cover Class	Species	Strata	Cover Class
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
	T S F G B L	+ 1 2 3 4 5 6 7 8		T S F G B L	+ 1 2 3 4 5 6 7 8
Incidental Wildlife Observations					
Species		Sign	Notes / Comments		
1					
2					
3					
4					
5					
Comments / Notes					

Aerial-based monitoring survey data sheet for establishment survey

Adapted from (Government of Alberta, 2017) Appendix 8

Appendix H. Ground-based Habitat Restoration Monitoring Survey Datasheet

Project ID	Date	Time	Crew	Flying conditions	Stocking density	Tree height	Evidence of human use		Evidence of wildlife use		Comments
							Type of Access	Level of Use	Type of Access	Level of Use	

## Appendix I. Study Design and Statistical Considerations for Monitoring (CHRF document)

### Study Design and Statistical Considerations

Developing robust inferences on a project's outcomes inherently depends on the project's study design and the statistical approaches used to analyze the monitoring data. Proponents should provide rationale for their choice of design and statistical analyses. Below are some general guidelines and recommendations to consider when developing a monitoring framework:

- i. Before-after-control-impact (BACI) designs<sup>1</sup> generally provide the strongest inferences
  - BACI designs involve randomly assigning sample units (see #2 below) to treatment and reference (or “control”) groups prior to treatment deployments. Reference groups allow for the control of environmental effects (e.g., annual weather changes) that may confound interpreting treatment effects.
  - Treatment and control units should be similar in their environmental attributes (i.e., land-cover type) to further isolate treatment effects.
  - Both groups are monitored before and after treatment deployment.
  - The BACI approach allows for multiple lines of evidence to evaluate treatment effects (before-after comparisons and treatment-control comparisons).
  - For ecological restoration projects at a single site, a before-after design may be enough, particularly if only vegetation growth is monitored.
- ii. Clearly define sample units
  - The size and shape of sample units should be biologically relevant and/or have relevance from a management perspective.
- iii. Sample units should be independent
  - Sample units need to be independent to avoid pseudo-replication. For example, if the response metric is wolf use of a linear feature, remote cameras placed 250-m apart on the same line cannot be considered independent because a wolf captured on one camera will have a high probability of being captured on the other camera. Proponents should provide rationale as to how sample units are independent from each other.
- iv. Consider power analyses to determine appropriate sample size(s)
  - Power is the probability of detecting a treatment effect, given that the effect truly exists.
  - General recommendation is to have power  $\geq 0.80$ , meaning there is an 80% probability of detecting a statistically significant effect, given that the effect truly exists.
  - The type of power analysis depends on the study design and the statistical framework for analyzing the data (see next point).
  - For BACI designs, power analyses can provide sample size estimates for treatment and control groups.
- v. Consider using the simplest statistical analyses to achieve the monitoring objective

- For BACI designs, t-tests and/or chi-square tests may be enough for evaluating treatment effects.
- For remote camera studies, more sophisticated statistical techniques may be required to account for low rates of occurrence and/or a high number of sites where the focal species never occurred (i.e., zero-inflated regression models).
- If predator use is the response metric, occurrence or occupancy modelling may be required. See Tattersall et al.<sup>2</sup> and Steenweg et al.<sup>3</sup> for examples.

vi. Notes on remote cameras

- Project teams should carefully consider whether remote cameras provide the most efficient way of monitoring effectiveness of treatment compared to other techniques. Although cameras are increasingly being used in wildlife studies, for species such as wolves that are relatively rare, rates of occurrence at a given camera will be low (e.g. 1 occurrence per 300 days<sup>4</sup>). These low rates of occurrence will require large sample sizes of cameras (i.e., >40 cameras) with long monitoring times (i.e., >1 year) to robustly evaluate for treatment effects. See Steenweg et al.<sup>3</sup> for further information on conducting power analyses for camera studies. Alternatively, see DeMars and Benesh<sup>5</sup> for a remote camera design that uses independent tests rather than occurrence as the response metric.
- Cameras should be serviced in the spring (after snowmelt) and fall to ensure adequate battery coverage during the snow-free season when predator use of linear features is highest and to avoid leaving compacted snow trails which may facilitate predator use of caribou habitat.
- To prevent damage and theft, consider using camera locks in areas used by the public.

In the following table, examples of monitoring techniques to achieve a goal is presented. The techniques are ordered from easiest to most challenging in terms of their implementation. Potential advantages and disadvantages for each technique are listed along with general considerations for study design and statistical analysis. Note that these considerations are general because projects will vary in their objective/goals, the response metric monitored, logistical feasibility and costs.

**Restoration Goal: Increase habitat intactness and quality to a state where it supports sustained use by caribou.**

**TABLE 10. EXAMPLES OF MONITORING TECHNIQUES TO EVALUATE EFFECTIVENESS OF ECOLOGICALLY RESTORING AREAS TO FUNCTIONAL CARIBOU HABITAT.**

Monitoring Technique	Purpose	Required Monitoring Data	Suggested Monitoring Frequency	Advantages	Disadvantages	Study Design and Statistical Considerations
Vegetation surveys	Monitor vegetation growth and recovery	Vegetation height and density; survival assessment; establishment survey	In Alberta, provincial recommendations for monitoring restoration of seismic lines suggests that survival assessments be performed 2-4 years after trans planting or 3-5 years after seeding	Tracks vegetation recovery to ensure the trajectory is moving toward functional caribou habitat	Labour intensive if ground-based sampling plots are used  Requires long-term monitoring (i.e., >10 years) to track return	Consider a stratified sampling design to account for different land-cover types, soil type and moisture regimes

# Appendix I. Study Design and Statistical Considerations for Monitoring (CHRF document)

Monitoring Technique	Purpose	Required Monitoring Data	Suggested Monitoring Frequency	Advantages	Disadvantages	Study Design and Statistical Considerations
			and establishment surveys be conducted after 8-10 years	Control-treatment comparisons can help optimize restoration techniques	to functional caribou habitat	
Lichen surveys	Monitor lichen growth and recovery	<p>Lichen % cover and/or biomass</p> <p>Percent cover can be visually estimated in sample plots, which can be placed systematically along line transects. See Dunford et al.<sup>9</sup> for an example</p> <p>Biomass can be modelled by regressing the weight of clipped subsamples against height. See Dunford et al.<sup>9</sup> for an example</p>	<p>Survival and % cover assessments should be performed at 2 and 5 years</p> <p>Slow growth of lichens (3-6 mm per year; Duncan et al.<sup>10</sup>) requires long-term monitoring</p>	<p>Low cost</p> <p>May not require control areas if the objective is simply to monitor survival and growth over time</p>	Requires long-term monitoring (e.g., >40 years) to track return to functional caribou habitat	Requires careful consideration of site selection (e.g., soil type and moisture regimes) and site preparation—see Duncan et al. <sup>10</sup>

## Appendix J. Background Readings

### Topic: Predator/Prey Dynamics

Serrouya, R., Dickie, M., DeMars, C. and S. Boutin. 2016. *Predicting the effects of restoring linear features on woodland caribou populations. Prepared for British Columbia Oil and Gas Research and Innovation Society (BC OGRIS).*

Dickie, M, Serrouya, R., DeMars, C., Cranston, J. and S. Boutin. 2017. *Evaluating functional recovery of habitat for threatened woodland caribou. Ecosphere 8(9)e01936.10.1002/ecs2.1936*

Pigeon, K., MacNearney, D., Nobert B, Finnegan, L. 2017. *Caribou and wolf behaviour in relation to oil and gas development. Prepared by fri Research for the British Columbia Oil and Gas Research Innovation Society (BCIP-2016-15).*

### Topic: Critical Habitat

Alberta Biodiversity Monitoring Institute (ABMI). 2017. *Prioritizing Zones for Caribou Habitat Restoration in the Canada's Oil Sands Innovation Alliance (COSIA) area. Version 2.0. Prepared for COSIA.*

Golder Associates Ltd. (Golder) and Explor. 2016. *Natural Recovery on Low Impact Seismic Lines in Northeast British Columbia (BCIP-2016-18). Submitted to BC Oil and Gas Research and Innovation Society. Report Number 1654243.*

### Topic: Habitat Restoration and Monitoring Programs

Golder Associates Ltd. (Golder). 2016b. *Parker Caribou Range: Boreal Caribou Restoration Pilot Program plan. Report Number 1529978/5000. Submitted to the British Columbia Oil and Gas Research and Innovation Society's Research and Environmental Monitoring Board (BC OGRIS REMB).*

Golder Associates Ltd. (Golder). 2017b. *Parker Caribou Range: BC OGRIS Zone 1 Habitat Restoration Implementation Vegetation Monitoring Program. Report Number 1778967-3000. Submitted to the British Columbia Oil and Gas Research and Innovation Society's Research and Environmental Monitoring Board (BC OGRIS REMB).*

Fitzpatrick, J. and N. Jenni. 2017. *Developing and Monitoring the Efficacy of Functional Restoration of Linear Features for Boreal woodland caribou- 1-Year Summary of Monitoring Data. Parker Caribou Range. Prepared by Matrix Solutions Inc. for the BC Oil and Gas Research and Innovation Society (BC OGRIS).*

Golder Associates Ltd. (Golder). 2018a. *Phase 2- Contract No. CS18FSJ0029: Quintette Caribou Habitat Implementation plan- FINAL. Report Number 1782773-010-R-Rev0. Submitted to the Ministry of Forests, Lands, Natural Resource Operations and Rural Development.*

### Topic: Habitat Restoration Guidelines and Frameworks

Toolkit – COSIA Knowledge Portal - <https://www.360tours.cosia.ca/toolkit/>

Fodo, D., O. Kovalchuk and R. Spyksma. 2018. *Road Rehabilitation Algorithm: Modeling Update. Prepared by Forsite Consultants Ltd., for BC Ministry of Forest, Land, Natural Resource Operations and Rural Development*



## Appendix J. Background Readings

*Pyper, M., Nishi, J and McNeil, L. 2014. Connecting knowledge to practice. Linear Feature Restoration in Caribou Habitat: A summary of current practices and a roadmap for future programs. Prepared by Fuse Consulting Ltd. for Canada's Oil Sands Innovation Alliance.*

*Golder Associates Ltd. (Golder). 2015a. Boreal Caribou Habitat Restoration Operational Toolkit for British Columbia. Report Number 1313720037. Submitted to the BC Science and Community Environmental Knowledge (SCEK) Fund's Research and Effectiveness Monitoring Board (REMB).*

*Golder Associates Ltd. (Golder). 2015c. BCIP-2016-02: Boreal Caribou Habitat Restoration Monitoring Framework. Report Number 1529986-001-R-Rev0. Submitted to the British Columbia Oil and Gas Research and Innovation Fund.*

*Government of Alberta. 2017. Provincial Restoration and Establishment Framework for Legacy Seismic Lines in Alberta.*

*Golder Associates Ltd. (Golder). 2018b. Enabling Solutions for Boreal Caribou Habitat Restoration: A Framework. Report Number 1788974. Prepared for the British Columbia Oil and Gas Research and Innovation Society Research and Effectiveness Monitoring Board (BC OGRIS REMB).*

*Society for Ecological Restoration. 2004. Integrating Ecosystem Restoration into Forest Management Practical Examples for Foresters. SER- BC Chapter. Available from:  
[http://sernbc.ca/pdf/ecosystem\\_restoration\\_forest\\_mgt.pdf](http://sernbc.ca/pdf/ecosystem_restoration_forest_mgt.pdf)*

Road Rehab General [https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nrs-climate-change/mitigation/forest-carbon-initiative/module\\_4\\_road\\_rehabilitation\\_web.pdf](https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nrs-climate-change/mitigation/forest-carbon-initiative/module_4_road_rehabilitation_web.pdf)

Road Rehab Criteria [https://intranet.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nrs-climate-change/mitigation/forest-carbon-initiative/appendix\\_1\\_-\\_road\\_rehabilitation\\_project\\_criteria.pdf](https://intranet.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nrs-climate-change/mitigation/forest-carbon-initiative/appendix_1_-_road_rehabilitation_project_criteria.pdf)

Engineering Standards: [https://intranet.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nrs-climate-change/mitigation/forest-carbon-initiative/appendix\\_2\\_-\\_road\\_rehabilitation\\_engineering\\_standards.pdf](https://intranet.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nrs-climate-change/mitigation/forest-carbon-initiative/appendix_2_-_road_rehabilitation_engineering_standards.pdf)

## Appendix K. Funding Sources/Grant Opportunities

### Integrated Investment Plans by Region

Each region in the province will have an Integrated Investment Specialist (IIS) that plays a key function in coordinating the various funding envelopes to support geographically focused priorities. The specialist leads the development of regional Integrated Investment Plan (IIP) for their Regions. The IIP document specifies what the categories are for potential investment noting provincial and regional priorities and what activities would likely be supported by the Land Manager. Potential funders that support those activities are summarized in this document.

**TABLE 11. SUMMARY OF POTENTIAL LENDERS.**

Area, Region	Integrated Investment Specialist	Contact Number
North Area, Northeast	Carmela Arevalo	778 576-8877
North Area, Omineca	Mike McLachlan	778 693-3002
North Area, Skeena	Vacant	250-847-7699
South Area, Kootenay Boundary	Julie Castonguay	250 825-1147
South Area, Cariboo	Christine Unghy	236 716-2274
South Area, Thompson Okanagan	Danya Leduc	778 362-7212
Coast Area, West Coast	Scott Scholefield	250-739-8431
Coast Area, South Coast	Aaron Smeeth	778-647-2002

### The Habitat Conservation Trust Foundation (HCTF)

The HCTF established the Caribou Habitat Restoration Fund (CHRF) to restore high-use caribou habitat in BC using functional and ecological restoration. This fund also supports work targeting other species. The CHRF is made possible by a \$2 million grant from the Province of BC. Any individual or organization capable of restoring habitat for caribou in BC can apply. The Province has identified priority herds and developed guidelines for selecting restoration areas and activities. An Eligible Activities List is available on-line.<sup>29</sup>

### The Fish and Wildlife Compensation Fund (FWCP)

The FWCP is a partnership between BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations and Public Stakeholders. The partners aim to conserve and enhance fish and wildlife in watershed impacted by BC Hydro dams. They have developed regional Action plans which define conservation prioritizes and potential projects which are considered for yearly grants.<sup>30</sup>

<sup>29</sup> <https://hctf.ca/caribou/>

<sup>30</sup> <http://fwcp.ca/>

## Forest Enhancement Society of British Columbia (FES-BC)

FES-BC has various purposes to advance environmental and resource stewardship of British Columbia's forests. Proposed projects that primarily focus on improving wildlife habitat are to be submitted to HCTF through their Restoration and Enhancement Grants application process and must meet HCTF review criteria and priorities.

## BC Community Gaming Grants

While this grant is not specifically designed for caribou restoration, it is available to support non-profit organizations that deliver community programs that benefit citizens of BC.

## Environment and Climate Change Canada funding programs

There are a number of federally available grants that could potentially feed into caribou restoration work. For example, the Aboriginal Fund for Species at Risk supported a caribou project through the Alberta First Nations Technical Services Advisory Group. This was a three-year Boreal Caribou monitoring project from 2013 - 2014 to 2015 - 2016 to contribute to caribou recovery efforts and build capacity within First Nations groups to conduct caribou monitoring projects.

## National Geographic

National Geographic offers three types of grants that "should be bold, innovative and potentially transformative and have a primary focus in conservation, education, research, storytelling, or technology." Wildlife is included in one of the key focus areas.

## International endangered species funding agencies

There are a range of independent national and international funding opportunities that are established for endangered species, including Canadian Wildlife Federation: Endangered Species Research Fund; World Wildlife Fund: WWF - Endangered Species Conservation and the IUCN Defenders of Wildlife to name a few.